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Royal Commission on
Electric Power Planning
with respect to the
Public Information Hearings



TRANSMISSION - ENVIRONMENTAL

Submission of
ONTARIO HYDRO
to the
Royal Commission
On Electric Power Planning
with respect to the
Public Information Hearings

March, 1976

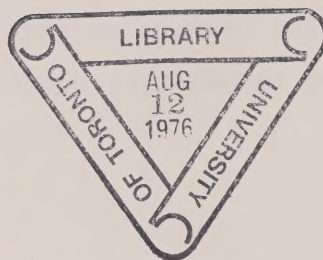


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Section 3 Transmission - Environmental
List of Short Forms

AM	Amplitude Modulated
CSA	Canadian Standards Association
dB	decibels
dBA	decibels on a-weighted network
EHV	Extra High Voltage
FM	Frequency Modulated
IEEE	Institute of Electrical and Electronic Engineers
kV/m	kilovolt per metre
PCB	Polychlorinated Biphenol Compound
pf	picofarad
ppm	parts per million
RI	Radio Interference
R/W	Right of Way
SF ₆	Sulphur Hexafluoride
TVI	Television Interference
UHV	Ultra High Voltage
uV/m	microvolts per metre



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TRANSMISSION LINES AND STATIONS - ENVIRONMENTAL
ASSESSMENT

Introduction

It is Ontario Hydro's objective to make a positive contribution to the quality of life of the people of the province by providing a reliable supply of electrical energy to meet Ontario's needs. The Corporation actively acknowledges the necessity of its locating, building, operating and maintaining transmission facilities in a manner which ensures the maximum net benefit to the province, region and community. This means reducing, to the greatest practical extent, any adverse effects those facilities might have on environmental conditions.

Ontario Hydro recognizes that high voltage transmission facilities, wherever located, cause some changes in the existing environment. Changes within the natural or man-modified environment are brought about by:

- (a) Acquiring land or property rights to accommodate the facilities;
- (b) Installing the facilities (including clearing and preparing construction sites and access routes, delivering materials, building tower foundations, assembling and erecting towers, stringing conductors, laying counterpoise);
- (c) The physical presence of the facilities;
- (d) Operating the facilities;
- (e) Maintaining and repairing the facilities;
- (f) Managing the land on which the facilities are located.

Because of the diversity of environmental conditions across the province, the potential for changes resulting from the introduction of transmission facilities differs from one area to another as regards what might be altered and to what extent. This potential for change can be predicted from a knowledge of both environmental conditions and standard design and implementation specifications.

The significance of any change lies in the effects that change might have, either directly or indirectly, on the quality of life of the people inhabiting or utilizing that area and of the people of the province or region as a whole, now and in the future. In general, such potential effects fall into one or more of three major categories:

(a) Ecological Effects

Changes in the quantity, quality or diversity of ecologically interdependent components of the natural environment (i.e. air, water, soil, plant life and animal life) can affect those biophysical and biochemical processes which are essential to the maintenance of healthy ecosystems and fundamental to the quality of life of the people of Ontario.

For example, compaction or rutting of surface soils by the passage of heavy construction equipment thereover, or the mixing of soil layers during excavation or site preparation activities, can inhibit or divert the movement of groundwater and limit the availability of soil nutrients to plant life. The removal or reduction of plant cover in areas of potentially erodible soils during installation or maintenance activities can result in accelerated soil erosion, thereby depriving those areas of their life-supporting nutrient base and depositing the eroded material elsewhere. Deposition of this material in a water course can detrimentally affect the quality of the stream or river by increasing turbidity and sedimentation. The removal of shade-giving trees from alongside coldwater streams can result in increased water temperatures and consequent decreased oxygen levels therein. Removing plant cover from areas of organic soils (i.e. wetlands), which act as natural water storage reservoirs, can reduce the storage capacity and change downstream flow characteristics. This can result in spring flooding or decreased summer flows downstream.

Furthermore, any of the aforementioned examples of disturbances of soils, water or vegetation, as well as the physical presence and operation of the transmission facilities themselves, can

1 affect the suitability of the terrestrial or
2 aquatic habitat for animal life by prohibiting or
3 interfering with physiological processes or
4 behavioural patterns related to feeding,
5 reproduction, migration, etc.
6

7 (b) Socioeconomic Effects
8

9 In a positive sense, perhaps the most significant
10 socioeconomic effects of additional high voltage
11 transmission facilities result from their
12 efficient and reliable delivery of electrical
13 power - an essential contributor to the lifestyle
14 of the vast majority of Ontarians and to the
15 economy of a growing province - from expanded or
16 new generating stations to load centres.
17

18 However, other changes resulting from the
19 introduction of high voltage transmission
20 facilities may detrimentally affect the social
21 and economic welfare of some individuals,
22 businesses and communities in the province by
23 reducing the availability of natural resources
24 upon which they rely for their living, by
25 limiting the structural facilities which
26 accommodate their activities, or by interfering
27 with the use of those resources or facilities.
28

29 As a result, such locally and provincially
30 important pursuits as food production, timber
31 production, sand and gravel extraction,
32 recreational activities, and residential,
33 commercial or industrial development may be
34 affected to some degree, both at the time the
35 facilities are introduced and thereafter for as
36 long as the facilities are in place and
37 operating.
38

39 On an individual basis, severance of properties,
40 placing of towers thereon, removal or relocation
41 of buildings, etc. can create the potential for
42 partial loss of financial investment and can
43 interfere with the future plans of people so
44 affected. For many parts of the province
45 official land use plans, restrictions and
46 policies exist, and violation of or conflict with
47 these can adversely affect provincial, regional
48 or local planning objectives.
49
50
51
52
53
54
55

Increasing construction and maintenance costs by adding new facilities, increasing line lengths and angles to avoid potential environmental problems, managing environmentally sensitive areas affected by facilities located therein, etc. can increase the cost of electrical power to Ontario's consumers.

(c) Psychological Effects

All of the aforementioned ecological and socio-economic effects of transmission facilities, whether actual or simply imagined, can have psychological effects on people. From a positive standpoint, most people in Ontario find comfort in the confidence that a reliable supply of electricity will be available when they need it. Conversely, the realization that equally essential natural systems and resources can be depleted or degraded, or the fear that personal ownership rights, health and safety might be in jeopardy, albeit for the benefit of Ontarians as a whole, are disturbing to many people.

A further important adverse psychological effect of introducing transmission facilities results from the changes they impose on the overall appearance of the landscape - the "visual effect". Each part of the landscape of Ontario has a distinct "character" dependent on the unique combination and interaction of its component elements (e.g. topography, vegetation, water, man-made structures). The addition of new elements (e.g. towerlines) to, or the deletion of existing elements from, that landscape will result in changes to the perceived character of the area. The effect of such changes will depend on the value which people place on the particular landscape as a result of its diversity, uniqueness, utility, "beauty", etc., now and in the future.

Ontario Hydro attempts to reduce the potential adverse effects of its transmission facilities by:

- (i) Openly planning the location, design and mode of implementation of needed facilities to avoid, as much as possible, the risk of causing adverse environmental changes and to

Line
Number

1 comply with overall provincial, regional and
2 local planning objectives - BEFORE THE FACT;

3
4 (ii) Implementing design specifications and
5 construction, operation and maintenance
6 procedures which will reduce to the greatest
7 possible extent the occurrence and magnitude
8 of adverse changes in areas where the risk
9 of their occurring persists - DURING THE
10 FACT;

11
12 (iii) Employing remedial or compensatory measures
13 where necessary to alleviate unavoidable
14 effects - AFTER THE FACT;

15
16 The implementation procedures and corrective measures
17 used in standard practice by Ontario Hydro are
18 described in Section 3.3.2. Where unique unavoidable
19 situations involving high risk of environmental
20 effects are encountered, special designs, procedures
21 or measures may be developed during the planning stage
22 or improvised as necessary on site.

23 3.3.1 Right of Way and Station Site Selection Studies

24
25 3.3.1.1 Purpose

26
27 Before proceeding with the acquisition of property
28 for, and the construction of transformer stations and
29 transmission lines, Ontario Hydro must obtain approval
30 of the provincial government. This approval will
31 depend upon Hydro's fulfilling the requirements of the
32 Environmental Assessment Act. Accordingly, Ontario
33 Hydro conducts, for each project, a comprehensive
34 environmental study which provides the rationale for
35 recommending, from among the technically feasible
36 alternative means of supplying an identified
37 electrical power need, that alternative which appears
38 to afford the greatest overall benefit.

39
40 3.3.1.2 Prerequisites of Studies

41
42 Each study, prior to its initiation, requires that the
43 need for additional transmission facilities has been
44 forecast and that the technically feasible alternative
45 means of satisfying that need have been identified.

Line
Number

3.3.1.3 Study Process

At the outset of any Right of Way or Station Site Selection Study an area which encompasses all possible locations for the facilities required by each of the feasible system alternatives is delineated. The boundaries of this study area are identified on the basis of major technical, economic and environmental constraints.

After the study area has been defined the task becomes one of determining what facilities in what location will satisfy the need with the greatest net benefit. Accomplishing this objective involves the stepwise elimination of possible alternatives and may require two phases of study.

In the initial phase the entire study area is examined at a macro level (small scale) to determine where generally within the area the facilities required by each alternative system plan could be located with the least likelihood of causing provincially or regionally significant adverse environmental changes. These broad pathways are referred to as "bands". The potential implications of locating the required facilities within each of the resultant bands are then compared. As a result, some system alternatives and parts of the study area are eliminated from further consideration.

In the second phase the bands associated with the remaining systems are studied in greater detail (larger scale) to identify specific alternative routes and station sites therein on which the required facilities could be located with the lowest overall risk of having adverse environmental effects. The implications of locating lines or stations on these alternative routes or sites are then compared to facilitate selection of the alternative to be recommended.

In some cases, where bands resulting from the first phase of study are very large, an intermediate phase is required. In other cases, where the original study area is very small and detailed consideration of the entire area is feasible, a single phase is sufficient.

In general, although each phase of study differs with respect to the level of detail (scale) at which the

problem is approached, each comprises the same basic chronological steps. The following discussion of the procedures used in the initial phase illustrates those steps.

During each phase and step of a study, Ontario Hydro maintains close liaison with the government ministries and provides for a mutual exchange of information with interested groups and individuals external to Hydro through the public participation program.

3.3.1.4 Method Used in Identifying Environmental
Implications of Transmission Alternatives - Phase 1

The method used to identify the environmental implications of transmission system alternatives includes:

- (a) The production of maps depicting geographic variation in environmental constraints;
- (b) The delineation, for each alternative system plan, of a set (or alternative sets) of transmission "bands", i.e. broad, linear areas within which the probability of finding environmentally acceptable locations for the transmission facilities required by a particular system plan appears greatest in light of the identified constraints;
- (c) The identification of the potential environmental implications of (or the risks of adverse environmental effects which would be associated with) locating the required transmission facilities in the bands delineated for each alternative system plan.

The identification of bands is predicted on the assumption that such bands must provide for the transmission of power as indicated by the system plan and must either avoid areas which present the greatest environmental constraints, or cross these areas on or adjacent to existing severences, or impinge upon them only where essential from a technical or economic standpoint. Areas of greatest constraint are identified according to one or more of the following criteria:

- (a) An officially stated or approved land use restriction, plan or policy which would be violated by the imposition of transmission facilities;
- (b) An environmentally imposed engineering problem, the satisfactory solution to which would result in substantial extra installation, operation or maintenance costs;
- (c) A relatively high probability that transmission facilities would cause provincially or regionally significant detrimental changes in the area or in the activities of the people who inhabit or use the area, now or in the foreseeable future.

To facilitate the kind of decision which must be made in identifying bands, it is appropriate to consider the potential effects of transmission facilities on those characteristics of, and activities occurring within the area which may contribute in a major way to the provincial or regional quality of life. These characteristics and activities, hereafter called factors, are considered in the following categories:

- (a) Stated land use restrictions, policies and planning objectives;
- (b) Urban development providing residential, industrial, commercial and institutional facilities;
- (c) Availability, quality, utilization and management of natural resources for food production, timber production, mineral extraction, recreational and cultural activities;
- (d) Life supporting ecological processes and major components of natural ecosystems;
- (e) Appearance of the landscape.

Six procedural steps are employed to implement the above approach to identifying and evaluating bands:

(1) Inventory of the Study Area

Inventory data is obtained from a variety of sources. Some information is acquired directly

1 from existing published data maps (e.g. Canada
2 Land Inventory, Ontario Land Inventory, other
3 federal and provincial government ministry maps,
4 Official Plans of Municipalities). Other
5 documented information requires interpretation
6 (e.g. topographic maps, Forest Resources
7 Inventory). In still other cases, new data is
8 collected through use of remote sensing imagery,
9 stereo interpretation of conventional black and
10 white or false colour aerial photographs, field
11 inspection, discussions with District or Regional
12 Government Ministry personnel, special interest
13 groups or associations, local planning boards and
14 individual citizens. This data is mapped at a
15 scale of 1:250,000 to depict geographic variation
16 throughout the study area in characteristics
17 related to one or more of the factors under
18 consideration.

19
20 This generalized, continuous line mapping
21 effectively subdivides the study area according
22 to each data variable and factor into smaller
23 areas of differing description (e.g. Figures
24 3.3.1-1 to 3.3.1-4). For ease of handling the
25 mapped information is encoded and computer stored
26 on the basis of 2 x 2 km, U.T.M. (Universal
27 Transverse Mercator) registered grid.

28 (2) Identification of Objectives
29

30 Recognizing that a primary intent of band
31 identification is to avoid areas of greatest
32 environmental constraint wherever possible, a
33 number of specific objectives are prepared with
34 respect to each factor by environmental analysts,
35 planners and others with specific expertise
36 related to that factor. Each objective
37 comprises:
38

- 39 i) A directive to avoid a particular type of
40 area characterized by specific descriptive
41 information contained within the inventory.
42
43 ii) An appended "because" clause outlining
44 reasons why such areas should be avoided, in
45 terms of the changes which might be expected
46 if transmission facilities were to be
47 located there and the anticipated
48 significance of those changes.
49

(3) Ranking Objectives

To facilitate ranking the identified objectives, each objective is recorded on a separate card. The cards are then ranked on the basis of a comparison of the "because" clauses, particularly that information regarding the significance of the anticipated changes.

(4) Identification of Constraint Areas

In general, areas of differing levels of constraint can be identified by applying the literal directives of the objectives, in the established order of priority, to the description of the study area, i.e., the mapped inventory. The computer is instructed to search the entire study area for, and so designate: first, all 2 x 2 km grid cells which exhibit the characteristics of the type of area described in Objective 1 on the priority list; second, all cells which exhibit characteristics of the type of area described in Objective 2; and so on, in order until each cell within the study area has been designated according to the highest ranked objective which can be applied thereto (as exemplified in Figure 3.3.1-5). To facilitate simple graphic display of the differing degrees of environmental constraint occurring in the study area, the objectives are then grouped into a few levels. These levels of objectives are then mapped as illustrated in Figure 3.3.1-6.

(5) Delineation of Bands

By using the simplified constraint map as an initial guide as to the environmentally "best" and "worst" areas to locate transmission facilities, general locations of bands to accommodate each alternative system plan are identified by coarse visual inspection. To delineate the approximate boundaries of the bands, and to indicate where bands might best traverse areas of relatively high constraint when necessary, the general band locations are checked against individual cell designations regarding the highest ranked objective applicable thereto and against the individual inventory maps (Figure 3.3.1-7).

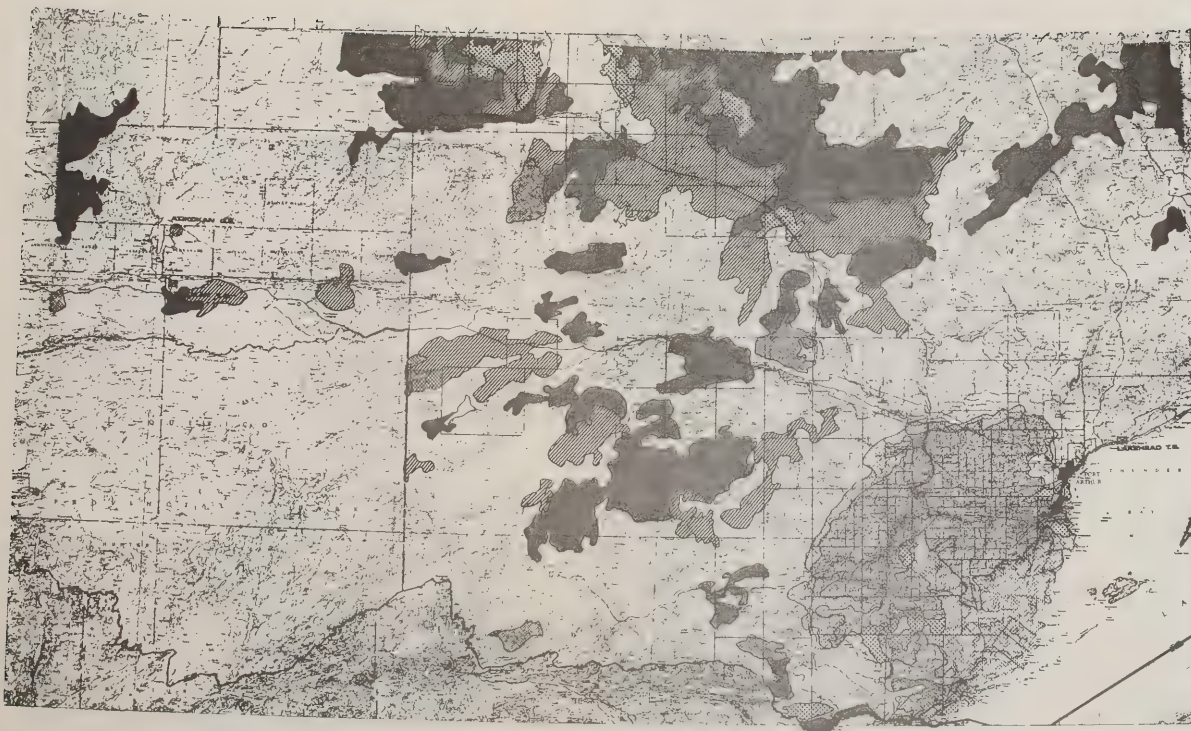
(6) Identifying Implications of Locating
Transmission Facilities With Bands

The bands so delineated for each alternative system comprise a network (or alternative networks) of broad pathways through the study area wherein the probability of finding environmentally suitable locations for the required transmission facilities appears greatest. However, all potential environmental problems have not been overcome. Therefore, it is necessary to identify for each system alternative (i.e. for each network of bands) the probability of incurring those potential environmental effects which persist within the relevant bands, i.e., the potential environmental implications of locating transmission facilities within the bands delineated for each system.

These implications can be expressed:









- a) In tabular form, in one or more of the following ways:
 - i) The success with which a given plan satisfies each environmental objective, with particular emphasis on those objectives of highest priority;
 - ii) The probability (or risk) of a given plan's violating each environmental objective or impinging upon specific environmental situations relating to each factor;
 - iii) The probable extent of such violations or impingements expressed in linear, area, volumetric and/or economic terms, if and where possible;
 - iv) the significance of such violations or impingements.
- b) In graphic form by superimposition of the bands to accommodate each plan over constraint factor and inventory maps.

When tabulated for each system alternative, with technical and cost implications and simplified to



ROUTE SELECTION STUDY FOR W 2 (MARMION LAKE SITE)

FOREST SPECIES ASSOCIATIONS

-  HARDWOOD POPLAR-WHITE BIRCH
-  MIXED POPLAR-WHITE BIRCH
-  MIXED POPLAR-WHITE BIRCH (70-*) BLACK SPRUCE (30-*)
-  WHITE SPRUCE-BALSAM FIR-POPLAR-WHITE BIRCH
-  WHITE SPRUCE-BALSAM FIR-POPLAR-WHITE BIRCH (70-*) BLACK SPRUCE (30-*)
-  JACK PINE
-  JACK PINE (70-*) BLACK SPRUCE (30-*)
-  BLACK SPRUCE

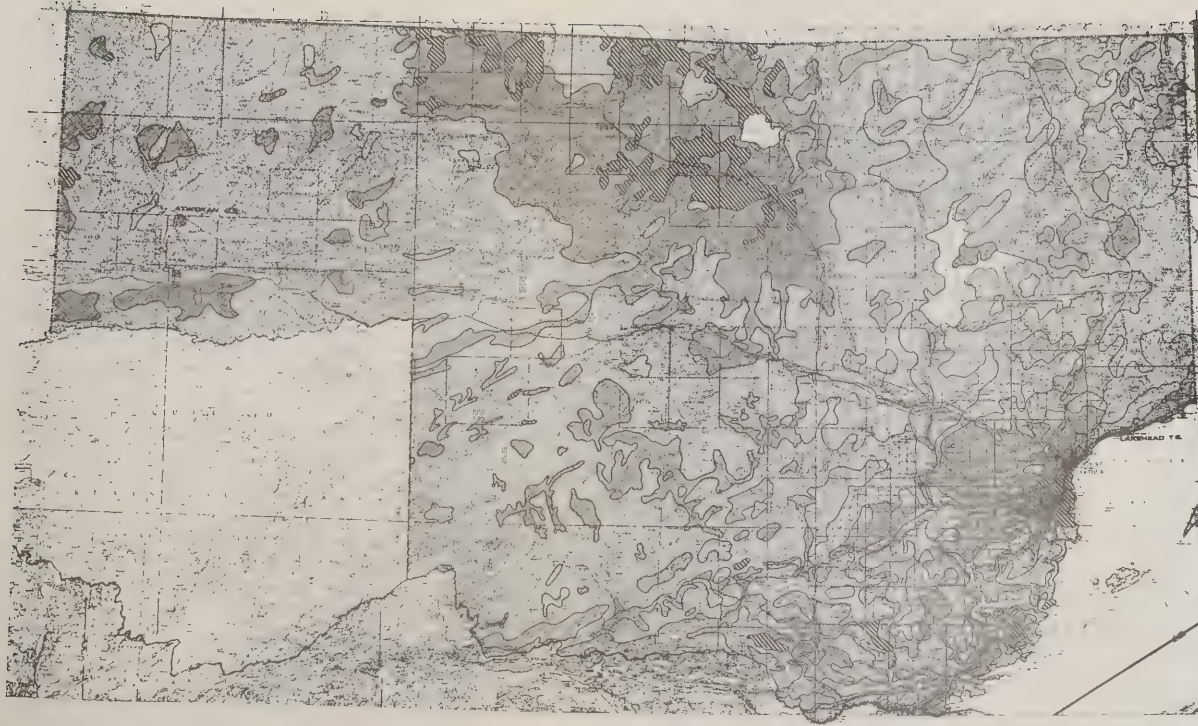
REVISION	DATA SOURCE
	- OBTAINED LAND INVENTORY "LAND CLASSIFICATION MAP" (S.A. 1981, 1982 AND 1983) - OBTAINED INVENTORY OF NATURAL RESOURCES (S.A. 1981) SCALE 1:50,000 DISCUSSION WITH MISS PERSCHKE, ON HIGHWAY



ONTARIO HYDRO
 ROUTE AND SITE SELECTION DIVISION







Figure 3.3.1-1



ROUTE SELECTION STUDY **FOR** **W 2 (MARMION LAKE SITE)**

TOPOGRAPHY

-  FLAT (0-15% SLOPE)
-  ROLLING (15-30% SLOPE)
-  HILLY (30-60% SLOPE)
-  VERY HILLY (60%+ SLOPE)

REVISION

DATA SOURCE

BLACK AND WHITE AERIAL PHOTO, 1960 AND 1961.
 NATIONAL AIR PHOTO LIBRARY, QUEBEC, QUEBEC
 AND REPRODUCED, OTTAWA.
 SCALE: 1:60,000 (1960)



ONTARIO HYDRO
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MAP
 SERIES NUM 10



Figure 3.3 1-2

ROUTE SELECTION STUDY FOR W 2 (MARMION LAKE SITE)

PHYSIOGRAPHIC FEATURES

- MORaine SAND & GRAVEL, MODIFIED BY LAKE ACTION
- MORaine UNMODIFIED
- SPILLWAYS
- KAME & ESKEr DEPOSITS UNMODIFIED SAND, GRAVEL AND BOULDERs
- TILL SILTY TO SANDY
- LOESS FINE SAND OR SILT WITH SOME OUTWASH
- TILL CLAY
- LACUSTRINE CLAY & SILT WITH SILTY SANDY TILL
- LACUSTRINE SAND WITH SILTY SANDY TILL
- DELTAIC SAND AND VALLEY TRAINS
- OUTWASH SAND, FINE SAND, GRAVEL
- BARE ROCK ERODED BY LAKE ACTION
- ESKErS

DIVISION DATA SOURCE

MURDOCH BRIDLEY MAP, CANADA, ASSESSMENT, 1968
1" = 4 MILES, PUBLISHED BY MINISTRY OF NATURAL RESOURCES, 605
MURDOCH BRIDLEY MAP, THUNDER BAY, 1968
1" = 4 MILES, PUBLISHED BY MINISTRY OF NATURAL RESOURCES, 605

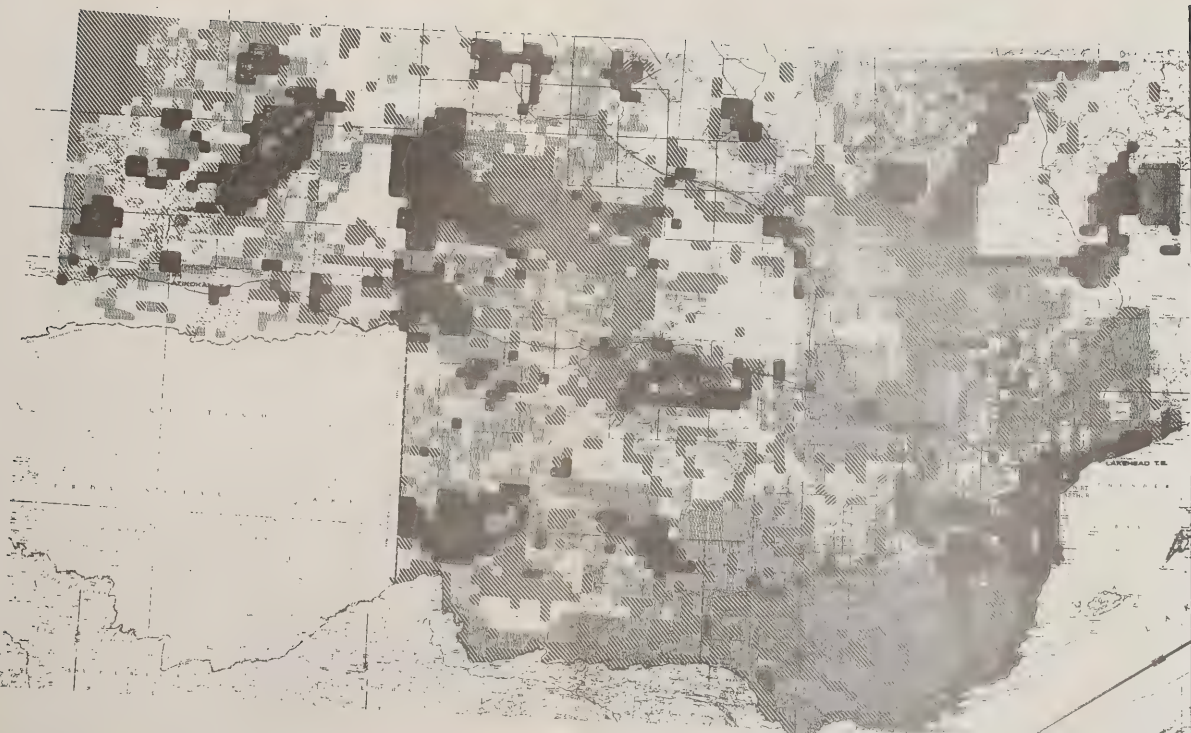


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

Figure 3.3 1-3

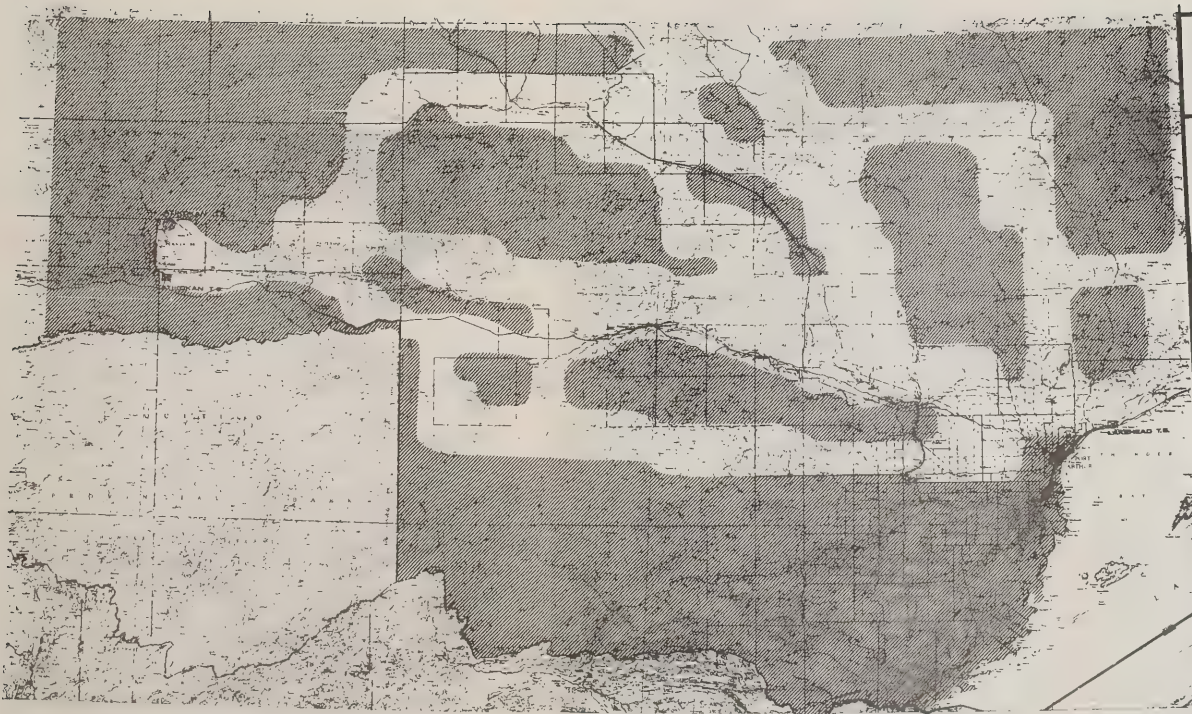


ROUTE SELECTION STUDY FOR W 2 (MARMION LAKE SITE)

CONSTRAINT AREAS

BANK	OBJECTIVE -		BANK	OBJECTIVE -	
	DATE	FAMILY		DATE	FAMILY
Farm Owner Coordinates 4100 West Central 4100 West Central 4100 West Central 4100 West Central 4100 West Central 4100 West Central 4100 West Central 4100 West Central 4100 West Central 4100 West Central	09	Subsistence & Institutional	29	W-Wildlife Habitat	
	10	Subsistence & Institutional	30	W-Mortality	
	09	Subsistence & Institutional	31	W-Nutrition	
	09	Subsistence & Institutional	32	W-Overpopulation	
	09	Subsistence & Institutional	33	W-Overpopulation	
	09	Subsistence & Institutional	34	W-Overpopulation	
	09	Subsistence & Institutional	35	W-Overpopulation	
	09	Subsistence & Institutional	36	W-Overpopulation	
	09	Subsistence & Institutional	37	W-Overpopulation	
	09	Subsistence & Institutional	38	W-Overpopulation	
Farm Owner Coordinates 4100 West Central 4100 West Central 4100 West Central 4100 West Central 4100 West Central 4100 West Central 4100 West Central 4100 West Central 4100 West Central 4100 West Central	09	Subsistence & Institutional	39	W-Overpopulation	
	10	Subsistence & Institutional	40	W-Overpopulation	
	09	Subsistence & Institutional	41	W-Overpopulation	
	09	Subsistence & Institutional	42	W-Overpopulation	
	09	Subsistence & Institutional	43	W-Overpopulation	
	09	Subsistence & Institutional	44	W-Overpopulation	
	09	Subsistence & Institutional	45	W-Overpopulation	
	09	Subsistence & Institutional	46	W-Overpopulation	
	09	Subsistence & Institutional	47	W-Overpopulation	
	09	Subsistence & Institutional	48	W-Overpopulation	

REVISION	DATA SOURCE					
	<p>The ranked objectives as identified on map C1, were grouped into five variable levels of importance, to assist in identifying possible locations for transmission routings.</p>					
	ONTARIO HYDRO ROUTE AND SITE SELECTION DIVISION				MAP SERIES NUMBER	
						



ROUTE SELECTION STUDY FOR W 2 (MARMION LAKE SITE)

PRELIMINARY TRANSMISSION BANDS FROM MARMION LAKE SITE TO LAKEHEAD T.S. AND TO ATIKOKAN T.S.



TRANSMISSION BANDS

REVISION
 1. 10/10/10
 2. 10/10/10

DATA SOURCE
 The bands (based on the linear "bands" within which the probability of finding suitable land use for the proposed transmission facilities appears greatest) were derived through considering: maps C1 & C2; the various land use maps; the data maps; including linear uses; a lake overlay map; and the system requirements.



ONTARIO HYDRO
 ROUTE AND SITE SELECTION DIVISION

MAP
 1:10,000



Figure 3.3.1-7

reflect only uncommon environmental, technical and economic costs and benefits, this information will provide a basis upon which alternative plans can be compared and evaluated.

3.3.2 Construction Practices and Right of Way Restoration Practices

The major operations in the construction of overhead transmission lines include the selective cutting of the right of way; establishment of construction access routes; the installation of tower foundations; the assembly and erection of towers; the stringing of the conductor; the installation of counterpoise; and clean-up and restoration of the right of way. Construction may be carried out either by Hydro's in-house construction staff or by contract forces, and in either case will comply with the practices prescribed in "Protection of the Environment During Power Line Construction" which is included as Appendix 3.3.2-A.

The following is a brief description of the various construction operations:

(a) Right of Way Clearing

Selective cutting, and restoration is carried out as detailed in "Specification for the Selective Cutting and Restoration of new 500, 230, 115 and 44 kV Transmission Line Right of Way", Appendix 3.2.2-B.

In general, selective cutting is employed in areas with a lower percentage of forested land, such as in farming areas, and also in recreational and vacation areas that are used frequently by the general public. The minimum clearing of trees and shrubs is done at each tower location that is needed to assemble and erect the tower. Between tower locations, trees which come within a minimum distance of the conductor and would interfere with the safe efficient operation of the line are removed. Trees are also removed where necessary, to provide construction access routes to tower locations.

Where lines pass through heavily forested lands, such as in Northern Ontario, most of the trees on the right of way are cut. Tree screens are left

the foundations. Excavated material is removed from the site or spread in a location suitable to the owner. Before starting work on the foundation top soil is removed and saved for reinstatement when the construction work is completed.

(d) Tower Assembly and Erection

Following the completion of the foundations, the next operation is the delivery of tower steel to each tower location in preparation for building the towers. The steel is transported from the material storage areas normally by truck. Although procedures are followed during this operation, as well as during the previous foundation operation, to minimize damage to fields and roads, a certain amount of damage is to be anticipated. This damage is repaired upon completion of the work, or appropriate compensation is paid to the land owner.

The individual steel members are assembled together to form sections of the tower which are laid out on the ground in a manner suitable for erection, which is normally done by means of a crane. In some cases, depending on the size of the tower, the tower is completely assembled on the ground and erected in one lift by a crane. If the location of the tower site is such that it is not accessible by crane, the tower may be erected by a gin pole. This is a single structural member supported in a vertical position by guy ropes and used to raise the tower sections. This method is very slow and very costly compared to the use of a crane and is therefore only used when crane access is impractical.

(e) Conductor Stringing

The installation of the line conductors is the next operation. The technique, which is now usually employed for this work, is known as "tension stringing" in which the conductors are pulled under tension through travellers (pulleys) attached to each tower. Being under tension, the conductors are kept off the ground at all times and thereby avoiding damage to objects underneath

Line
Number

1 the conductors as well as to the conductors
2 themselves. After insulator strings and
3 travellers are hung on the towers, the first step
4 in tension stringing is to install a light rope
5 along the section of the line to be strung.
6 These sections vary in length up to about 30,000
7 ft. A helicopter is used to fly this rope along
8 the right of way for deposit in the travellers.
9 This rope is then used to pull in larger ropes
10 and steel cables until one of sufficient strength
11 pulls through the conductors.

12
13 After all the conductors are pulled into place by
14 this method, they are tightened to a specified
15 tension. This tension ensures that the line
16 maintains the correct ground clearance under all
17 operating conditions. Following this, the
18 conductors are clamped at each tower and damping
19 devices are installed on the conductors to limit
20 vibration. Where bundled conductors are used on
21 higher voltage lines spacing devices must also be
22 installed along the span between the towers.
23 Ground cables, which are attached at the tower
24 peak positions above the conductors, are strung
25 in a similar manner.

26
27 Specialized equipment is required for this method
28 of stringing, and it is moved from section to
29 section along the right of way as the stringing
30 proceeds. This method is effective in minimizing
31 damage to the terrain as it avoids the need to
32 move heavy equipment along the full length of the
33 right of way and is compatible with selective
34 cutting.

35 (f) Counterpoise
36

37 To ensure that the line will operate efficiently
38 when in service, it is necessary that the
39 electrical ground resistance at each tower be
40 low. To accomplish this a ground electrode is
41 installed at each tower. If, because of soil
42 conditions, the ground resistance at many of the
43 towers is too high, additional grounding must be
44 installed. The normal procedure in this case is
45 to bury two continuous wires along the right of
46 way, one at each side of the towers. These wires
47 are normally buried to a depth of 18" in
48 cultivated ground and 8" in bush areas and in
49

rocky ground. The wires are installed by a tractor which carries the ground wire on reels and buries the wire as it proceeds down the right of way by means of a plow attachment. The wires are then connected to each tower. An efficient grounding system on a transmission line minimizes the chance of operational outages due to lightning.

(g) Clean-up and Restoration

The final stage of construction is the clean-up of the right of way to be sure that all construction materials are removed. This is an ongoing procedure during the construction of the line, but a final clean-up is also carried out. Any necessary repairs to fences, fields and roads are completed. Grading, if required, at the tower sites is also completed in preparation for further restoration.

After the construction clean-up is completed, a program of restoration is carried out to bring the right-of-way or station site to the optimum state possible. Restoration of disturbed areas, outside of cultivated land, is carried out by seeding with compatible grasses or legumes to retard weed growth and to help to prevent erosion. Trees may be planted at suitable locations such as road and water crossings, pond and spring areas where residual trees were removed or additional trees are required. A detailed description of clean-up and restoration practices is included in Appendix 3.3.2-B.

Line
Number

APPENDIX 3.3.2-A

PROTECTION OF THE ENVIRONMENT
DURING POWER LINE CONSTRUCTION

Lines and Stations Construction
Practices No. CP87-0 L

PROTECTION OF THE ENVIRONMENT
DURING POWER LINE CONSTRUCTION

The way in which the Lines and Stations Construction Department goes about its work can have a significant effect on how Ontario Hydro meets the environmental expectation of the people in the province.

The Department's policy is described in the following guidelines. They are to be followed by all levels of supervision as applicable.

1.0 GENERAL

- 1.1 All employees on a line construction project must be aware of the policies outlined in this instruction. Make sure they are also aware of any specific policy or restriction which may apply to the project they are on.
- 1.2 Designate a field contact supervisor to deal with anything pertaining to the environment on each job. This supervisor could be one of the general foremen.
- 1.3 Keep protection of the environment in mind when choosing methods and equipment for a job.
- 1.4 If possible, plan the work for the time of year when least damage will result to the environment.
- 1.5 Cross natural water courses only when absolutely necessary and only after obtaining approval from the Zone Superintendent.
- 1.6 Make sure that surplus material and debris is removed and the work locations always are kept neat and tidy. Debris must either be removed to an approved disposal area or buried at least two feet down on the right of way.
- 1.7 Construction forces must not cut or destroy any trees without agreement of the Forestry Department.
- 1.8 Keep clearing and grading of construction areas to a minimum and prevent erosion.

- 1.9 Do a minimum of grubbing. Take removed stumps to a suitable location on the right of way or to an approved disposal area.
- 1.10 Do not dump or bury oil, gasoline or other pollutants on the right of way. This type of waste must be taken to an approved disposal facility.
- 1.11 Keep disposal of material by burning to a minimum, and always follow Government and Hydro regulations.
- 1.12 Keep dust, smoke and fumes to a minimum in sensitive areas. Do not leave vehicles idling unnecessarily.
- 1.13 Plan the work so the traffic on access roads can be kept to a minimum.
- 1.14 Consider the noise nuisance and keep it to a minimum.
- 1.15 Do not blast in or near streams.
- 1.16 Do not open borrow pits without permission but obtain fill from established pits and quarries.
- 1.17 Maintain fences and gates in a state equal to or better than the condition they were found in.
- 1.18 Locate tile drains before construction starts if at all possible. This can usually be done from aerial photographs or by talking to the landowners.

2.0 MATERIAL YARDS AND CAMPS

- 2.1 Choose sites which are hidden from sight or blend with the terrain whenever possible.
- 2.2 Keep the sites neat and tidy at all times.
- 2.3 Restore the sites to their original or natural state when no longer required.
- 2.4 Do not unduly damage trees, brush and other permanent vegetation.

Line
Number

1 3.0 RIGHT OF WAY ACCESS

2
3 3.1 Use only the specified access routes unless permission
4 to use other routes first has been obtained from the
5 project engineer.

6
7 3.2 Make use of existing roads if at all possible.

8
9 3.3 Keep additional access roads within the confines of
10 the right of way as a general rule. However, if
11 building a temporary access road in this location will
12 do severe harm to the environment, other routes must
13 be considered.

14
15 3.4 Locate the access road so that it can be used for all
16 future line construction on the same right of way.

17
18 3.5 Avoid wetlands and steep slopes if possible.

19
20 3.6 Limit the width of the road to 15 feet except on
21 curves where the width may be increased to handle the
22 longest component to be transported.

23
24 3.7 Prevent excessive rutting and mixing of sub-soil and
25 top-soil.

26
27 3.8 Use only the established access road for all traffic.

28
29 3.9 Keep a constant watch on the condition of the access
30 routes and if scarring and erosion damage becomes too
31 severe remedial action must be taken at once.

32
33 3.10 Seek approval from local authorities with regard to
34 size and location before placing culverts in road
35 ditches.

36
37
38 4.0 CLEARING OF TOWER SITES

39
40 4.1 Clearing of the tower sites will normally be done by
41 the Forestry Department. The area to be cleared will
42 be kept as small as possible and will be discussed and
43 agreed on by construction and forestry personnel.

44
45 4.2 Trees which are to remain in the work area must be
46 clearly marked to this effect and protected.

Line
Number

1 5.0 FOUNDATIONS

- 2
- 3 5.1 Preserve all trees close to the tower foundation if
- 4 they were not cleared by by the Forestry Department.
- 5
- 6 5.2 Minimize any disturbance of vegetation and topsoil in
- 7 the surrounding area.
- 8
- 9 5.3 Avoid mixing of topsoil and subsoil during the
- 10 excavation so they can be replaced properly when the
- 11 site is being restored.
- 12
- 13 5.4 Stop excavated material and other pollutants from
- 14 getting into natural water courses.
- 15
- 16 5.5 Spread surplus soil over the tower site unless the
- 17 specifications call for disposal in other locations.
- 18
- 19 5.6 Haul away, bury or otherwise dispose of surplus
- 20 concrete, bentonite, and other construction materials.
- 21
- 22 5.7 When pumping is necessary make sure the sediment in
- 23 the discharge water does not get into nearby streams.
- 24

25 6.0 TOWER ASSEMBLY AND ERECTION

- 26
- 27 6.1 Select methods and equipment to minimize harm to the
- 28 environment.
- 29
- 30 6.2 Avoid unnecessary damage to trees, shrubs and
- 31 vegetation during the assembly operation.
- 32

33 7.0 STRINGING

- 34
- 35 7.1 Use the tension stringing method in most cases since
- 36 this method will do the least damage to the vegetation
- 37 along the right of way. In areas where it can be
- 38 established that slack stringing will not do any
- 39 appreciable damage this method is also acceptable.
- 40
- 41 7.2 Limit the traffic on the right of way to the access
- 42 road and plan your work to make as few trips as
- 43 possible.
- 44
- 45 7.3 Make use of existing clear areas near established
- 46 roads for the stringing set-ups whenever possible.
- 47 Keep the area you use to a minimum by carefully
- 48
- 49
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- 51
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Line
Number

1 locating the machines, conductor tie downs and
2 conductor reel storage.

3
4 7.4 Do not blade or grade the set-up area unless it is
5 absolutely necessary and keep it as small as you can.

6
7 7.5 Avoid trenching for temporary anchors whenever
8 possible. Use screw-type anchors, inclined logs or
9 steel beams instead.

10
11 7.6 Collect and dispose of wire and cable clippings daily.
12 If left on the right of way they may cause damage to
13 farm machinery and death to farm animals. Disposal
14 bins must be set up in convenient locations.

15
16 7.7 Clean and leave each set-up location in a respectable
17 condition before you move on to the next location.
18

19 8.0 COUNTERPOISE
20

21 8.1 Use hand placement of counterpoise conductor in
22 sensitive areas such as near natural water courses.
23

24 8.2 Obtain light, narrow trenching and laying machines for
25 selective cutting areas. Wide equipment may damage
26 the trees.
27

28 8.3 Be careful not to create unwanted erosion channels
29 during counterpoise installation. Leave cut-off dikes
30 in the furrow at close intervals on sloping ground.
31
32

33 9.0 CLEANUP
34

35 9.1 Give the right of way, access road and storage
36 locations a final inspection at the end of the
37 construction program. Leave the right of way free of
38 all litter, hardware and waste material including
39 concrete. Secure all fences and gates before pulling
40 out.
41

42 9.2 Remove all temporary culverts and restore drainage
43 courses and embankments to an acceptable condition.
44

45 9.3 Restore all land which was disturbed during
46 construction to a reasonable state by:
47 (a) filling deep ruts and holes
48 (b) grading around tower sites and pole footings
49
50

Line
Number

- (c) restoring access roads to an acceptable
condition
(d) leave the right of way ready for final
seeding and rehabilitation by the Forestry
Department.

9.4 Carry out complete restoration as soon as the
construction work is finished on sections of line,
such as between township limits.

Carrying out these measures will require extra
planning and care, and some additonal costs will
likely be involved. The results will, however, be
well worthwhile in improved public relations and
protection of the countryside.

Line
Number

APPENDIX 3.3.2-B

SPECIFICATIONS FOR THE SELECTIVE
CUTTING & RESTORATION OF NEW
500, 230, 115 AND
44 KV TRANSMISSION LINE
RIGHTS-OF-WAY.

Line
Number

1 Specifications for the Selective Cutting
2 and Restoration of New 500, 230, 115 and 44 kV
3 Transmission Line Rights of Way
4
5

6 The following specifications have been prepared by the
7 Transmission and Distribution Projects Department of the
8 Stations, Transmission and Distribution Projects Division and
9 the Forestry Department of the System Maintenance Division.

10
11 1. Specification "A"

12 Specifications for the Selective Cutting and
13 Restoration of New Rights of Way in Developed Areas
14 with a Low Percentage of Forested Lands.
15

16 2. Specification "B"

17 Specifications for the Selective Cutting and
18 Restoration of New Rights of Way in Less Developed
19 Areas with a High Percentage of Forested Lands.
20
21
22
23
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Line
Number

1 Specifications for the Selective Cutting
2 and Restoration of New 500, 230, 115 and 44 kV
3 Transmission Line Rights of Way
4

5
6 The development of new rights-of-way for Ontario Hydro
7 transmission lines of the above voltages shall be carried out
8 under one of the two following specifications.
9

10 Specification "A" shall be used where the right-of-way
11 crosses urban or farm areas that have a low percentage of
12 forested lands relative to non-forested lands and where most
13 township road allowances have been developed as public roads.
14 It shall also be used through or near park and vacation areas
15 frequented by the general public.
16

17 Specification "B" shall be used where the right-of-way
18 is remote from urban and farm areas, forested lands make up
19 most of the ground cover and few public roads cross or are
20 adjacent to it.
21

22 On projects controlled by the Stations, Transmission
23 and Distribution Projects Division, that Division will have the
24 responsibility for the choice of Specification "A" or "B" after
25 consultation with the Forestry Department. The Region will
26 have the responsibility for the choice of Specification for
27 projects under Regional control.
28

29 In both Specification "A" and "B" when the terms Line
30 Maintenance Department and Forestry Department are used, they
31 refer to either the Region or System Maintenance Division, as
32 appropriate.
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Specification "A"

INTRODUCTION

These specifications shall apply to all new rights of way for 500, 230, 115 and 44 kV transmission lines in developed areas with a low percentage of forested lands. They shall be followed to ensure the safe and reliable operation of the line and at the same time have the line blend with its surroundings and cause as little change to the environment as possible. Separate specifications cover less developed areas with a high percentage of forested lands.

To carry out these specifications, co-operation and good communications shall be required among the Regions, and the Transmission and Distribution Projects, Property and System Maintenance Divisions. Once a project has begun, it shall require, in particular, the closest co-operation between the Lines and Stations Construction Zone and the Forestry Department. For example, this co-operation would be important if there were a design change during construction such as a change in a tower location. If this occurs, the Forestry Department must be made aware of the change so it can provide the proper conductor tree clearances and the cutting for the revised tower and steel assembly areas.

The selective cutting of trees, planting of trees and shrubs, seeding of ground covers, restoration of the rights of way after construction and other related activities shall be the responsibility of the Forestry Department and all pertinent Municipal, Provincial, and Dominion Government Acts and Regulations shall be followed including commitments made in the Environmental Assessment Statement.

The work shall be carried out by Forestry tradesmen or by approved contractors under the supervision of the Forestry Department.

SELECTIVE CUTTING AND PRUNING OF TREES

Selective Cutting

The degree of cutting in woodlots will vary depending on such factors as ecological and visual impact of the line, tower location in relation to the woodlot, and age, height and species of the trees. Except where clear cutting is to be carried out, as covered elsewhere in these specifications, the following vegetation shall be allowed to remain.

1. Species of trees and shrubs that at maturity will not come within the specified clearances from the conductors. These compatible species will vary with the conductor height. For example, a species may be compatible near towers or in a valley but not compatible at mid-span on level ground.

2. Slow growing species that at maturity will grow within the specified clearance but are required for such purposes as screening the right of way, preventing soil erosion or protecting ecologically sensitive areas. Pruning may be required to provide the specified conductor clearance for these slow growing trees. If pruning would result in a mutilated appearance, the tree shall be removed instead of pruned.

In all areas of the right of way, fast growing species shall be removed.

On the right of way no tree shall be left that in falling will come closer to the nearest conductor than:

15 feet - 500 kV lines

10 feet - 230 and 115 kV lines

5 feet - 44 kV lines

Trees off the right of way are covered later under the heading of Danger Trees.

Pruning of Trees

All clearances shall be measured from the maximum sag and swing positions.

Maximum sag is defined as the final sag at the maximum conductor temperature or the sag at the design loaded condition of wind and ice whichever is the greater.

This maximum sag will be as shown on the profile drawing of the line and maximum swing can be determined from the "Design Standard for Transmission Lines" book, Table 7, Section ET2.

The minimum clearances between trees and the nearest conductor at its maximum sag and swing shall be as follows:

Line
Number

Voltage

Clearance

500 kV
230 kV
115 kV
44 kV

15 feet
10 feet
10 feet
5 feet

At the time of cutting, allowance must be made to provide for the estimated growth that will occur before the first tree maintenance operation. This is to ensure that the above minimum clearances are maintained at all times.

The total clearance will be the minimum clearance plus an additional allowance depending on species, site conditions and time of the next pruning cycle.

Danger Trees

On 500 kV lines, all trees off the right of way that cannot be pruned and that in falling would come within 15 feet of a conductor shall be removed.

On 230 and 115 kV lines danger trees are those off the right of way that are dead, shallow-rooted, rotted or leaning, which cannot satisfactorily be pruned and that in falling would come within 10 feet of the nearest conductor. These trees shall be removed. Trees off the right of way that are sound, straight, and deep-rooted even if they could strike the line shall not be considered danger trees and shall not be removed unless they will strike more than one circuit. In this case if a tree cannot satisfactorily be pruned, it shall be removed.

On 44 kV lines, as on 230 and 115 kV lines, the same definition and conditions apply except the minimum clearance is 5 feet.

Any trees which must be pruned or removed on private property (off the right of way) shall be marked and recorded on "Condemned Tree Report" forms for the Transmission and Distribution Projects Division to request property rights. Preferably these should be determined before final settlement with the owner. Trees on Hydro property do not have to be recorded and can be felled at the time the selective cutting is being carried out.

Clear-Cutting for Access

The first trees to be cut will be those that permit access to the tower or pole sites. Existing roads are to be

1 used if possible. The width and location of the access road
2 for construction and, if applicable, for maintenance shall be
3 determined by mutual agreement between the Lines and Stations
4 Construction Zone and the Line Maintenance and Forestry
5 Departments. The road shall be as inconspicuous as possible
6 and shall be so located that tree cutting and damage to the
7 environment are kept to a minimum. It should be curved if
8 necessary to avoid long vistas down the right of way. The
9 location of permanent and temporary culverts will be determined
10 during road location.

11 Clear-Cutting for Structure Sites

13 Tower or pole sites shall be clear-cut except for
14 shrubs and other vegetation that will not interfere with
15 construction. The size, shape and location of this clearing in
16 relation to the structure shall be determined by agreement
17 between Lines and Stations Construction Zone, Line Maintenance
18 and Forestry Departments.

20 Clear-Cutting to Extend an Existing Field

22 If all the following conditions prevail, it will be in
23 order to clear-cut if the proposed land use is for pasture only
24 and clear-cut and grub if for cultivated crops:

- 26 1. The owner expresses a desire for an extension of a
27 field into the right of way.
- 29 2. The cutting will be acceptable aesthetically.
- 31 3. The location to be cut is not ecologically sensitive.
- 33 4. It will be advantageous to Ontario Hydro from a
34 maintenance point of view.
- 36 5. The soil lends itself to the new land use.

38 Ecologically Sensitive Areas

40 Such locations as streams, wet lands, those subject to
41 soil erosion or those containing unique flora or fauna will as
42 much as possible be left in their natural state. Any potential
43 disturbance to drainage or forest and ground cover will be
44 identified then rectified or minimized.

1 Placing Counterpoise

2
3 During this work, the Lines and Stations Construction
4 Zone shall be assisted by the Line Maintenance and Forestry
5 Departments to determine the best location for the counterpoise
6 along the right of way, keeping in mind the vegetation and
7 possible soil erosion problems.
8

9 Stump Treatment

10
11 On the main access roads, stumps shall not exceed
12 three inches above ground level. On secondary roads and
13 elsewhere on the right of way, stumps shall not exceed six
14 inches. Stumps capable of suckering shall be treated in
15 accordance with Hydro Specification No. L-167-72 (Chemical
16 Control of Vegetation, Insect and Fungi) unless otherwise
17 specified.
18

19 Disposal of Felled Material

20 The disposal of felled trees is dependent upon the
21 value of the timber and its accessibility.
22

23 (a) Salvable Timber

24
25 Salvable timber is that which can be moved to a
26 processing point without incurring a loss. Every
27 effort shall be made to salvage such timber. Before
28 cutting into lengths, the end use must first be
29 determined and the proper trimming or broomage
30 allowance left on each piece.
31

32 (b) Non-Salvable Timber

33
34 Non-salvable timber shall be burned, buried, chipped
35 or cut to standard log lengths to a four-inch top and
36 piled neatly on the edge of the right of way, or cut
37 to shorter lengths and piled neatly on the right of
38 way, depending on the local conditions such as burning
39 regulations and the ownership of the right of way.
40

41 Burning is the least preferable method but should be
42 used when the others are not feasible. When burning
43 is used, care must be taken not to damage trees that
44 are to remain standing, including their roots.
45 Special care must be taken in areas where the forest
46 floor may burn because of a high accumulation of
47 humus.
48
49
50

Line
Number

Piles of wood must not obstruct the construction of roads, the placing of counterpoise or access for future maintenance.

Tops and limbs shall be disposed of by chipping, lopping and scattering, piling and crushing by tractor or where regulations permit, by burning. Where lopped and scattered, no part shall be left higher than 18 inches above ground level. No logs or brush shall be piled and left in tillable areas or watercourses.

RIGHT-OF-WAY RESTORATION

Responsibility of Lines and Stations Construction

The initial clean-up of the right of way after the construction of the line shall be the responsibility of Lines and Stations Construction. The responsibility shall include removal of all litter, hardware, waste concrete and uprooted stumps and the restoration of fences and gates which have been broken or removed. All land which has been disturbed by heavy equipment and trucks shall be restored to a reasonable state. This shall include the elimination of deep ruts and holes by filling or grading, the appropriate grading around tower and pole footings, the removal of temporary culverts and the restoration of temporary access roads to their original grades.

Responsibility of Forestry

Tree and Shrub Planting

Where screening or other planting is appropriate and where no residual trees can be left or where the number left are inadequate, trees shall be planted at sensitive locations such as road and water crossings and pond and spring areas. To help screen a structure from an adjacent property owner, trees may be planted where appropriate either on the right of way or on the adjacent property owner's land if this is mutually agreeable.

The trees to be planted shall be suitable to the local site conditions and will be similar to the existing vegetation in the vicinity. Trees planted under a conductor should preferably be of a species that at maturity will not grow within the specified clearance from the conductor or failing that be of a slow-growing nature.

At each structure site previously cleared for construction, compatible species shall be allowed to regrow, or appropriate trees or shrubs planted, except for an area required to be kept clear for line maintenance, the size of which will be determined in consultation with the Line Maintenance Department.

Ground Covers

All areas that are to be kept clear of trees and shrubs shall be seeded with grasses and/or legumes. The seeding is to be done as soon as practical to prevent soil erosion. The species to be sown will be determined by the site, time of seeding and maintenance practices and be compatible with neighbouring farm practices such as the growing of certified seeds. Temporary crops, such as oats or perennial rye, may be used until such time as the permanent seeding can take place.

In areas where soil erosion has taken place or where a potential erosion problem exists, the erosion shall be controlled by mulches such as straw or chips or other means until such time as the permanent cover crops take over this function.

Reforestation

In townships with less than 15 percent of the farm area in woodlots, an acreage equivalent to that selectively cut may be reforested. This planting may take place on the adjacent property owner's land, land designated by the Ministry of Natural Resources, lands owned by the township, county, or local Conservation Authority, or on land owned by Ontario Hydro suitable for this purpose.

If the equivalent acreage has not been attained when these categories are exhausted, the reforestation program will be considered complete.

Inspection of Right of Way

After Construction

Once the construction of the line has been completed, a check shall be made to ensure the proper clearances exist between conductors and trees and all debris such as brush, tops, limbs and non-salvable logs have been treated as specified.

Line
Number

After Restoration

After restoration of the right of way a check shall be made to ensure ground covers are well established, soil erosion is being controlled, permanent culverts are working satisfactorily, planted trees and shrubs are growing and healthy, and fences including gates are in good condition.

Specification "B"

These specifications shall apply to all new rights of way in less developed areas with a high percentage of forested lands for voltages of 500, 230, 115 and 44 kV.

During right of way selective cutting and restoration, all pertinent Municipal, Provincial and Dominion Government Acts and Regulations shall be followed, including commitments made in the Environmental Assessment Statement.

RESPONSIBILITY

The Lines and Stations Construction Department of the Transmission and Distribution Projects Division shall be responsible for the cutting of new rights of way under these specifications, except where it delegates this responsibility to the Forestry Department.

SELECTIVE CUTTING

The specified width of the right of way for all lines shall normally be cut free of all standing trees, shrubs and underbrush except as stated later in this specification.

(a) Danger Trees

On 500 kV lines, all trees off the right of way that cannot be pruned and that in falling would come within 15 feet of a conductor shall be removed.

On 230 and 115 kV lines danger trees are those off the right of way that are dead, shallow-rooted, rotted or leaning, which cannot satisfactorily be pruned and that in falling would come within 10 feet of the nearest conductor. Trees off the right of way that are sound, straight and deep-rooted, even if they could strike the line, shall not be considered danger trees and shall not be removed unless so specified by the Forestry Department. An exception to this will be trees that in falling could strike more than one circuit. In this case, if a tree cannot satisfactorily be pruned, it shall be removed.

On 44 kV lines as on 230 and 115 kV lines the same definition and conditions apply except the minimum clearance is 5 feet.

The marking of danger trees shall be the responsibility of the Forestry Department. If circumstances are such that it is not economical for contractors to remove danger trees, this responsibility may also be placed on the Forestry Department.

Trees to be Left Standing

Small trees and shrubs such as Sumac, Viburnums, Dogwood, Ground Juniper, Elderberry, Labrador Tea, etc, which in their lifetime will not exceed ten feet in height under 44 kV transmission lines or fifteen feet in height under 500, 230 and 115 kV transmission lines shall be left standing. Trees of a taller growing nature may be left in valleys but in such cases the Forestry Department shall be contacted to ensure they will be compatible with the height of the conductors. Trees and shrubs to be left standing may prove an obstacle to construction in some locations; in these cases a reasonable amount of clearing may be carried out to permit construction to proceed.

(a) Special Treatment

Special treatment shall be required for highly valued hedges and orchards and for trees such as may be found in National and Provincial Parks and Conservation areas frequented by the public and on some private property. In such situations, Specification "A" shall be used and the responsibility for obtaining sufficient clearance, while maintaining the aesthetic appearance of the trees shall be placed on the Forestry Department at the request of the Lines and Stations Construction Zone.

(b) Tree Screening at Crossings

Where a right of way crosses a public road, or navigable water, sufficient trees must be left standing to screen the power corridor. If the existing trees are not satisfactory for screening, trees of a size and species compatible with overhead conductors may be planted at designated crossings.

When it is necessary to construct a road or to string cable through the tree screen, it shall be done in such a manner as to create minimum detracton from the aesthetic value of the screen.

1 All clearing, pruning or planting in the designated
2 screening area shall be carried out by the Forestry Department
3 or under its direction.
4

5 Screening will take place in the following situations:
6

- 7 1. Where bush is within 500 feet from a crossing, the
8 screen should be a minimum of 100 feet thick and be as
9 close to the crossing as possible.
- 10 2. Where bush is beyond 500 feet from a crossing, the
11 need for a screen shall be determined by the Lines and
12 Stations Construction Zone, having regard for the
13 aesthetic value. If deemed necessary to leave a
14 screen at these locations, the Forestry Department
15 shall be contacted to provide the appropriate
16 treatment.
17

18 The Forestry Department will require reasonable
19 advance notice so that the above work can be completed on
20 schedule.
21

22 Disposal of Felled Trees 23

24 The disposal of felled trees is dependent on the value
25 of the timber and the accessibility of the location.
26

27 (a) Salvable Timber 28

29 Salvable timber is that which can be moved to a
30 processing point without incurring a loss. Every
31 effort shall be made to salvage such timber. Before
32 cutting into lengths, the end use must first be
33 determined and the proper trimming or broomage
34 allowance left on each piece.
35

36 (b) Non-Salvable Timber 37

38 The method of disposing of non-salvable timber will
39 depend on the accessibility of the location.
40

41 (i) Accessible Area 42

43 In areas that are accessible to vehicular
44 clearing equipment, non-salvable tree trunks
45 shall be burned, or trimmed to a four-inch top
46 and piled neatly along the right of way. The
47 piles must not obstruct the construction of
48 roads, the placing of counterpoise or the access
49

for future maintenance of the right of way. Limbs, brush and tops shall be scattered, burned or chipped, but where scattered shall be lopped so that no part will be higher than 18 inches above the ground. No stumps shall be left higher than six inches above ground level.

No logs shall be left adjacent to a public road or water crossing within 200 feet of the crossing or more as determined by the topography. The limbs, brush and tops shall be burned or chipped.

(ii) Inaccessible Areas

In inaccessible areas where the use of vehicular clearing equipment is not economical, the tree trunks may be left scattered on the right of way. In such cases, the trunks shall be cut so that the entire length shall be in contact with the ground. No criss-crossing of logs shall be permitted. Brush, limbs and tops shall be scattered or burned, but where scattered shall be lopped so that no part will be higher than 18 inches above the ground. No stumps shall be left higher than 12 inches above ground. If necessary, coniferous stumps shall be cut lower to eliminate the bottom limbs to prevent regrowth.

In both of the above areas, the Line Maintenance and Forestry Departments shall be consulted to determine if a maintenance road is required and, if so, to provide the specifications for it.

Placing Counterpoise

During this work, the Lines and Stations Construction Zone shall be assisted by the Line Maintenance and Forestry Departments to determine the best locations for the counterpoise along the right of way, keeping in mind the vegetation, and possible soil erosion problems.

Stump Treatment

Stumps capable of suckering shall be treated in accordance with Ontario Hydro Specification No. L-167-72 (Chemical Control of Vegetation, Insect and Fungi) unless otherwise specified.

1 RESTORATION OF RIGHT-OF-WAY

3 Ground Covers

5 All areas that are to be kept clear of trees and
6 shrubs shall be seeded with grasses and/or legumes.

8 On areas likely to erode, care must be taken to ensure
9 the forest floor and ground covers are disturbed as little as
10 possible. This includes the right of way and the access road
11 to it. Locations of potential soil erosion are to be reported
12 by the Lines and Stations Construction Zone to the Forestry
13 Department, who will be responsible for controlling the erosion
14 and for all seeding and planting.

15 Clean-Up of Right of Way

17 The clean-up of the right of way after the
18 construction of the line shall be the responsibility of the
19 Lines and Stations Construction Zone. This responsibility
20 shall include removal of all litter, hardware, waste concrete
21 and uprooted stumps and the restoring of fences and gates which
22 have been broken or removed. Also all land which has been
23 disturbed by heavy equipment and trucks shall be restored to a
24 reasonable state. This shall include the elimination of deep
25 ruts and holes by filling or grading, appropriate grading
26 around tower and pole footings, the removal of temporary
27 culverts, the restoration of temporary access roads to their
28 original grades, and the assurance that all debris such as
29 brush, tops, limbs and non-salvable logs have been treated as
30 specified.

32 Inspection of the Right of Way

34 After Construction

36 After construction of the line has been completed, the
37 Forestry Department will ensure the proper clearances exist
38 between conductors and trees.

40 After Restoration

42 After the restoration of the right of way, it will also
43 ensure that ground covers are well established, soil
44 erosion is being controlled, permanent culverts are working
45 satisfactorily, planted trees and shrubs are growing and
46 healthy, and fences including gates are in good condition.

Line
Number

1 3.3.3 Right of Way and Transmission Line Management
2 Practices

4 3.3.3.1 Right of Way Land and Vegetation Management

5
6 Once located and established, transmission lines and
7 their associated right of way are maintained and
8 managed as required by the Corporation's safety,
9 reliability, economic and good citizenship standards.
10 This includes not only the control of vegetation
11 (brush and trees) that is incompatible with overhead
12 power lines, but also such activities as the
13 protection of ecologically sensitive areas, the
14 establishment and monitoring of multi-use projects
15 (parks, wildlife habitat, recreation areas) and
16 landscaping and grounds maintenance.

17
18 The Corporation recognizes the need for a qualified
19 field staff capable of implementing such policies and
20 has recruited and trained accordingly.

21
22 Right of way land and vegetation management activities
23 fall within four general categories:

24 (a) Tree Pruning and Removal

25
26 To prevent power failures, and to ensure the
27 safety of the public and maintenance employees
28 alike, trees must not be allowed to come closer
29 than a specified distance to energized apparatus.
30 This distance varies with the voltage of the
31 line. In order to minimize the visual and
32 environmental impact of the line, the vegetation
33 that remains following the selective cutting and
34 restoration of the rights of way must be
35 carefully managed.

36
37 To accomplish the above aims, foot patrols are
38 carried out at least once every two years on high
39 voltage rights of way in order to identify
40 potentially dangerous tree conditions. Tree
41 pruning and removal work is done on a two to
42 three year cycle basis by trained Hydro foresters
43 using modern equipment and techniques.

44
45 (b) Brush Control

46
47 Incompatible, fast growing woody vegetation
48 (brush) must be controlled for the same reasons
49

Line
Number

as trees. This is done on an average of every five to eight years depending on growth rates and locations.

Control is achieved by cutting, by the selective use of government approved herbicides, by biological control methods or by combinations of these techniques. Biological control consists of the establishment and/or encouragement of vigorous low growing compatible vegetation, such as grasses, legumes and shrubs, which provide competition for seedlings of tree species. Herbicide application is supervised by licenced personnel, and is done in accordance with federal and provincial legislation.

(c) Landscaping, Grounds Maintenance and Weed Control

Landscaping and grounds maintenance activities ensure that Corporation properties are designed and maintained to a standard that is compatible with the surrounding community. Weed control programs are carried out to comply with the regulations of the provincial Weed Control Act.

(d) Ecologically Sensitive Areas

It is possible that some areas along rights of way may be designated as having provincial or regional ecological significance. Other areas may have a more localized significance, but still require special management treatment. An example of such areas would be wetlands and other areas where the risk of stream sedimentation or soil erosion is evident.

Mitigation anmanagement practices include the stability of the hydrologic cycle in wetlands, the maintenance of stream temperature in cold-water streams, the planting of ground covers such as grasses, legumes and shrubs, to prevent or rectify erosion, the proper installation and maintenance of culverts and the judicious use of herbicides, mechanical cutting and biological control in appropriate situations.

Some rights of way are managed to sustain or attract wildlife. Some are managed to limit access, thus avoiding excessive traffic where

such traffic could be detrimental to a sensitive environment.

3.3.3.2 Transmission Line Maintenance

Three categories of maintenance have been established for the transmission system. These are as follows:

(a) Running Maintenance

Routine

These are planned repairs of a localized nature which have to be carried out occasionally and are usually of one-half to one-day duration.

These repairs could require the moving in of trucks and there is the possibility of crop damage and damage to the ground. These might occur on the average of once per year at one location for each 100-mile section of line.

Diagnostic

This is maintenance work in the nature of an examination of the condition of the transmission system and is carried out on a planned schedule.

Examples of this type of maintenance are:

(i) Helicopter Patrols

Regular patrols of transmission lines carried out in accordance with the following schedule:

500 kV lines - 8 times each year

230 kV lines - 6 times each year

115 kV lines - 4 times each year

(ii) A walking physical inspection of the lines is carried out once a year.

Neither helicopter or walking patrols cause crop or ground damage and in general, this type of maintenance activity has a minimal effect on rights of way or property owners.

(b) Major Maintenance

These are planned repairs that could involve extensive work on a structure, such as footing repairs, or could cover several structures or miles of line, such as skywire replacement.

These repairs are usually planned as a result of conditions found during diagnostic maintenance.

They could be of several days duration and could cause crop damage or damage to the ground. The use of helicopters on such items as skywire replacement greatly reduces the amount of damage to property.

Major maintenance items are usually of such a nature as to permit long range planning and therefore can be scheduled to minimize the impact on rights of way and to property owners.

(c) Emergency Maintenance

Minor

These are repairs that must be carried out as quickly as possible and are usually restricted to one structure, such as the replacement of a string of broken insulators.

They are normally of one-half to one-day duration and could require the moving in of trucks with the resultant possibility of crop damage and damage to the ground.

Major

Major emergencies are usually the result of severe adverse weather conditions such as ice storms or tornadoes. They can affect several structures or miles of line.

In most cases it is necessary to restore the transmission line to service as quickly as possible and therefore heavy equipment and material must be brought into the area immediately.

1 These repairs can cause damage to crops and to
2 the ground. However, the use of helicopters and
3 special all-terrain vehicles can greatly assist
4 in minimizing the damage.
5

6 In the planning and execution of all maintenance
7 programs, a major consideration is to limit as much as
8 possible the disruption to farm practices and to the
9 environment.
10

11 The extended use of helicopters and the utilization of
12 new and improved all-terrain vehicles in all
13 maintenance practices greatly contributes to reducing
14 the effect of maintenance requirements on rights of
15 way and on property owners.
16

17 In cases where damage to farm practices or the
18 environment has been unavoidable, the necessary
19 restoration measures are carried out by Hydro, or the
20 owner is compensated for the cost of such restoration,
21 to return the right of way as nearly as possible to
22 its original state.
23

24 3.3.3.3 Monitoring of Effects

25 The nature and magnitude of changes to the natural and
26 social environment resulting from the construction,
27 operation and maintenance of transmission facilities
28 can vary widely depending upon the characteristics of
29 the area being traversed. To obtain factual
30 documentation about the effects in these diverse
31 environmental settings, Ontario Hydro has instituted
32 on new and existing rights of way an ongoing program
33 of monitoring studies. The results of these studies
34 will be used in developing and refining prediction
35 procedures (the results of studies on farm
36 productivity are already being applied in the
37 environmental study methodology) and in establishing
38 new or improved construction and long term management
39 practices to reduce effects.
40

41 Monitoring studies are conducted in one of two ways;
42 either through a systematic collection of data on new
43 projects during construction and subsequent
44 maintenance phases, or through special studies
45 designed to answer specific questions. Typical of the
46 former are a series of field trials being conducted in
47 co-operation with the Ministry of Agriculture and Food
48 to assess the effects of transmission lines on the
49

productivity of various types of farming enterprises and also a three year investigation of the effects of soil compaction from heavy vehicles on crop yields. Other studies are documenting in the Beverly Swamp the effects of transmission facilities on a wetland environment. From these efforts is developed a picture of the actual changes which transmission facilities can reasonably be expected to create and an assessment of the effectiveness of mitigating techniques.

Ontario Hydro will be conducting such studies on an ongoing basis to improve its knowledge about transmission effects and because of the need to examine the environmental implications of changes in technology and practices. To anticipate requirements for such studies and to assist in assigning priorities among them, Ontario Hydro will maintain communication with the Ministry of the Environment and other affected ministries or agencies.

3.3.4 Electrical Effect on the Environment (Humans, Animals, Vegetation)

The operation of transmission lines produces electric and magnetic fields in the space around the lines. The effect of the electric field is to induce voltages and/or currents on objects in the space near the line. The magnetic field induces voltages and currents in metallic objects near the line. Under certain conditions, corona is generated. Corona can produce audio, radio and television noise near the line and traces of ozone adjacent to the conductor.

Some of the effects must be controlled to ensure safe and reliable operation of the lines. Others must be regulated to reduce to acceptable levels interference with other public services and other users of the lands beneath and adjacent to the lines. The magnitude of each of the effects depends on the line voltage and/or current, line height, conductor spacing and design, and the construction practices followed. The effects are discussed below.

(a) Corona

Corona (1,2) can occur on conductors and line components when the electric field intensity or voltage gradient at the conductor surface exceeds

the insulation strength of air immediately around the conductors.

The research conducted in the 1950's by Ontario Hydro established the criteria for the design of EHV transmission lines to be virtually free of corona under fair weather conditions. This is accomplished by controlling the conductor size, bundle arrangement and phase spacing. To ensure that the benefit of the above factors is not reduced, corona free conductor hardware was designed and a guide for handling and stringing of conductors was developed.

By controlling corona levels, the audio, radio and television noise and ozone effects are reduced.

In foul weather, corona activity increases due to electric field distortions caused by water drops on the conductor surface.

(b) Ozone

Ozone is a naturally occurring gas related to oxygen and having a characteristic odour.

High voltage transmission lines make no significant addition to the amount of ozone present in the atmosphere at ground level under any weather conditions (1, 3, 4, 5).

(c) Radio Interference (RI)

Radio noise (1, 6, 7, 8) is generated by corona on various line components and by minute discharges at small air gaps that may exist with loose hardware. Figures 3.3.4-1 to 3.3.4-3 show the calculated Radio Noise profiles for some of the rights of way shown in Figures 3.1.3-6 to 3.1.3-9 inclusive. The radio noise values are expressed in dB above 1 uV/m, as measured by a meter conforming to CSA Standard C108.1.2. Figure 3.3.4-4 is included to show the calculated radio noise profile for earlier Ontario Hydro 230 kV two circuit lines. The favourable experience with these lines and with thousands of miles of line operating all over the world at voltages up to 765 kV is the best assurance that radio

reception will be satisfactory. Only in exceptional cases has reception been impaired and most of these problems have been successfully resolved.

National standards (Canadian Electrical Code, Part III, CSA Standard C108.3.1) protect local signals in the AM radio band in fair weather. The prescribed values of tolerable noise levels are 50, 57 and 60 dB for 230 kV, 500 kV and 765 kV lines respectively, measured at a point 50 feet laterally from the outermost conductor at ground level. Ontario Hydro's criterion is to limit the maximum fair weather level at a point 10 feet outside the right of way to 40 dB, which at least equals the national standard in all cases.

In foul weather, interference levels will increase due to increased corona. These levels will produce some interference with the weaker local AM signals. Due to the inherent noise-rejection properties of FM receivers, there should be no detectable interference with any reasonable FM signal in fair or foul weather.

(d) Television Interference (TVI)

The minute electrical arcing generated from loose conductor support assemblies or other hardware can also produce interference at very high frequencies (within FM and TV frequency bands). It is not difficult to detect and can be readily corrected.

Precipitation-type television interference (1, 7, 9, 10) occurs where there is light drizzle, heavy rain, dry snow or wet snow on the conductors. These are known as foul weather conditions. Efforts have been made to correlate foul weather television interference with foul weather radio interference. A study conducted for 500 kV lines has shown that foul weather TVI levels are less than 2 percent of the foul weather RI levels.

The IEEE Subcommittee on Radio Noise concluded that there is no confirmed data that TVI is caused by corona from overhead power lines during fair weather conditions (7).

Shielding and "ghost" effects caused by transmission lines have been rare and minimal. One reason may be that they are masked by the much larger effects produced by large buildings. Tests have shown that some effects may be noticed close to very tall transmission line structures in open country. In such cases, re-orientation of the receiving antenna will usually provide a remedy.

(e) Audible Noise

EHV transmission lines can create audible noise (1, 11, 12, 13) to some extent. It occurs mainly during heavy precipitation when corona generation is at its maximum.

It can be limited by designing the lines to reduce the electric field intensity at the surface of the power conductors; for example, by using larger conductors. Figures 3.3.4-5 to 3.3.4-7 show the calculated audible noise profiles across the rights of way for foul weather conditions for some typical cases.

In the USA, some complaints have occurred involving EHV lines operating at higher conductor surface voltage stresses than Ontario Hydro's design practice permits. The USA experience has shown that some complaints are received with audible noise levels between 52.5 and 58.5 dBA and numerous complaints occur when the audible level exceeds 59 dBA. By comparison, average traffic on a street corner produces a noise level of 70 to 80 dBA and conversational speech about 60 to 70 dBA. A typical business office has a sound level of about 50 to 60 dBA.

Maximum calculated noise levels for Ontario Hydro 500 kV lines, during heavy rains, are approximately 55 dBA at the edges of the rights of way.

(f) Electromagnetic Induction

Current flowing in the conductors of power lines causes an electromagnetically induced voltage to appear in parallel conductors (1, 14, 15, 16, 25). These conductors may be other transmission

lines, communication circuits, fences, pipe lines, or other metallic objects, either above ground or below, insulated or uninsulated.

The induced voltage appearing at the open ends of partially grounded parallel conductors can be in the order of 0.1 volts per mile per ampere of line current (14). The effect is independent of the line voltage, but increases with line current and the length of the parallel and decreases as the parallel conductors are separated.

Properly developed design, construction and operating practices will eliminate any hazardous electromagnetic induction effects.

(g) Electrostatic Induction

Energized conductors are surrounded by an electric field, sometimes referred to as an electrostatic field (1, 17-26 incl.). The magnitude of the electrostatic field under transmission lines depends on the voltage level of the conductor and the distance from the conductor to the ground. Figures 3.3.4-8 and 3.3.4-9 show the profile of the calculated electric fields across the right of way at ground level for some of the proposed line arrangements being considered for multiple line rights of way. Two conditions are shown in each figure. One depicts the electric field strengths (expressed as voltage gradient at ground level) for lines carrying their normal maximum loads. The second shows the ground gradients with one circuit out of service, and the other circuit carrying the maximum emergency load. These emergency conditions would be very infrequent and of short duration.

The electric field strengths under Ontario Hydro lines, even under these emergency conditions, are less than the field strengths that would exist under lines at the minimum clearances specified in the Canadian Electrical Code, CSA Standard C22.3 No. 1.

Figures 3.3.4-8 and 3.3.4-9, show the calculated value of the maximum field gradient at maximum normal loading.

(h) Biological Effects of High Voltage Electric Fields

During the past ten years there has been growing concern about the possible biological effects of electric fields induced by very high voltage power lines and substations. Although Ontario Hydro is convinced that there have been no significant health effects on workers exposed regularly to high intensity electric fields, Ontario Hydro keeps well informed on research and literature on this subject. The most significant issue is whether long term exposure to electric and magnetic fields can have deleterious effects on human, animal and plant life.

Research to date in Western Europe and America has failed to provide any significant evidence of harmful biological effects. On the other hand, studies performed in the USSR report some undesirable effects on workers in high voltage substations. Many of these effects were subjective or clinically not significant. Laboratory studies on small animals done in the USA in simulated electric field environment have been somewhat contradictory or inconclusive.

(i) USSR Studies (27, 28, 29, 30, 37)

Workers occupationally exposed to high voltage electric fields in the complex environment of switchyards complained of disorders such as headache, tiredness, lassitude, excessive sweating, irritability and loss of sexual libido. Clinical patterns described were mainly subjective with little or no evidence of clinically significant disease. Coronary artery disease found in three men over 50 years of age would not be unusual in any group of 45 males. Most of the blood changes described appear to be of little clinical significance.

In a second paper, increases in blood pressure and pulse with exposure to 500 kV appear to be quite within normal limits. It is difficult to interpret the significance of the Soviet findings. Most physicians who

have studies their research carefully agree that the psychological symptoms are probably related to unhappiness with the job, the location of the station or the high noise in the switchyards. Most of the physical findings would be common to any similar group of workers unexposed to electric fields.

It is significant to note that the permissible field intensities under transmission lines in the USSR are considerably higher than those under lines in Canada (37).

(ii) "Power over People" by Louise B. Young (31)

This book has been widely read and publicized in the media. Mrs. Young's original concern was with the aesthetics of transmission lines and towers. Subsequently she condemned utilities for building transmission lines, citing high corona discharges with the alleged production of ozone that this implies. She quoted the Russian research but produced little evidence to substantiate biological effects. Subsequent studies have proven that insufficient ozone is produced to affect health or vegetation.

(iii) Review of Literature and Research by Dr. Andrew A. Marino (32)

Dr. Marino is a biophysicist whose primary interest has been the effect of electric current on bone. Most of his experimentation has been done on rats. He has also reviewed extensively the literature regarding biological effects of electric fields on laboratory animals.

His main conclusion is that electrical fields have a biological effect on living organisms. From his own experiments on rats he concludes that electric fields produce a specific stress reaction. He has done no studies on humans who have been exposed to the electric fields of switchyards or

transmission lines. In spite of this, he has recommended that 765-kV lines should not be built.

(iv) Research by Dr. Robert O. Becker (33)

Dr. Becker is an orthopedic surgeon who has worked with Dr. Marino. His research is highly theoretical, bearing little resemblance to actual field transmission line conditions. He makes the assumption that what applies to experimental animals in the laboratory, applies equally to humans in proximity to high voltage conductors. As in the case of his colleague, there is no evidence that he has done any practical measurement of electric currents under field conditions.

(v) Johns Hopkins University Study 1972 by Drs. M.L. Singewald, O.R. Langworthy and W.B. Kouwenhoven (34)

This study was done on ten linemen working on 765-kV and 345-kV lines over a period of about nine years. They were in excellent health and between the ages of 30 to 47 years at the beginning of the study. Some worked bare handed and others used live line tools. The bare-handed workers were protected by conductive clothing and gloves.

Each lineman received seven complete physical and psychological examinations together with extensive laboratory tests, including electrocardiogram and eletroencephalogram. X-rays of the chest and hands were done at each examination. Sperm counts were done by a urologist at each examination and were found to be normal.

These very thorough examinations revealed no significant changes of any kind with all the men remaining healthy. No change which could possibly be related to electric field exposure was found throughout the study. The psychiatric assessment of emotional

status was directly opposite to the
observations of the Russians (27).

- (vi) Biological Measurements in Rodents Exposed
Continuously Through their Adult Life to
Pulsed Electromagnetic Radiation
- by S.J. Baum, M.E. Ekstrom, W.D. Skidmore,
D.E. Wyant and J.L. Atkinson (35)

Rodents were exposed continuously for 94
weeks of their adult life to very strong
electromagnetic fields. Thorough blood and
bone marrow studies, relating to effects on
fertility and reproductive capability, were
done. The rats were also examined for the
development of tumors and other adverse
health effects.

At no time did any of the biological
measurements in over 300 irradiated male
rats and 40 female rats show any ill effects
of the electromagnetic pulse radiation. In
this study 300 control rats were also
examined. The female rats which were
exposed throughout their gestation period
gave birth to normal progeny both from a
first and second pregnancy.

The conclusions of this research are in
sharp contrast to those of Drs. Marino and
Becker.

- (vii) Study by Pierre F. Roberge, M.D. -
Hydro Quebec (36)

This study on 57 electrical workers was done
in the latter half of 1975. All men had
worked for Hydro Quebec for a minimum of 2
years as maintenance electricians on 765-kV
substations.

The paper has not yet been published but
Ontario Hydro has been provided with a
summary. Publication is awaiting completion
of laboratory studies.

The clinical and psychological studies
failed to show any significant health
effects which could be ascribed to exposure

to high voltage electric fields. Dr. Roberge mentions specifically that the results did not show the syndromes reported by the Russians.

(viii) Ontario Hydro Experience and Planned Research

In Ontario Hydro about one hundred linemen work regularly bare hand or with live line tools on 230 and 500-kV lines. In addition, many others work in high voltage substations and on lines of lower voltage. While no definitive medical studies have been done on these men, many have been seen medically for other reasons. They have lived normal lives, have normal families and have shown no signs of poor health or disease which can be attributed to electromagnetic or electrostatic fields.

On the basis of the above and other extensive study of research and literature, Ontario Hydro believes there are no significant deleterious effects on human health from high voltage alternating current electric fields. However, with the present state of knowledge it is imperative to keep an open mind. Therefore, Ontario Hydro recommended a specific study of about 30 linemen and electrical workers who have been exposed to high voltage fields for at least five years. An equal or larger number of controls would also be examined.

A thorough examination, similar to that done in the Johns Hopkins study, is planned by Ontario Hydro annually for at least two and hopefully five years. To avoid any suggestion of bias, the study will be done by outside specialists and co-ordinated by the University of Toronto.

Ontario Hydro hopes that by keeping well informed on world-wide research and published reports and by doing its own study, concern about exposure to high voltage electric fields will be dispelled.

(i) Fences, Building, Irrigation Pipes

As discussed in (f) and (g) above, electrostatic and electromagnetic voltages and currents are induced in metallic objects located in the electric and magnetic fields generated by transmission lines (14, 17-20 incl.). These metallic objects can be fences, irrigation pipes, antennas, roofs and walls of buildings, eavestroughs and downspouts. To eliminate any possible hazards from induced voltages and currents, metallic objects close to the line are grounded.

Most fences are adequately grounded because of their type of construction. Those that are not, are grounded at intervals frequent enough to keep electromagnetically induced voltages and circulating currents to acceptable levels. They are also grounded at gates and at random breaks in the fences. Electric fences are grounded through filters. Irrigation systems, which do not have a metallic contact with ground, should be adequately grounded.

All large metallic buildings or structures, which are close to the right of way and insulated from ground, are grounded if necessary. No buildings are allowed directly under transmission lines.

(j) Lightning and Fault Currents

All high voltage towers are grounded. Overhead ground cables are used to carry fault and lightning stroke currents to ground. They are positioned to intercept lightning strokes and thereby shield the power conductor. They also provide some shielding to the ground below. If lightning should strike a line, the lightning current will seek the shortest path through the tower to ground. This current will produce a rise in voltage on the tower and in the adjacent ground due to the resistance of the ground to the flow of current. Similar voltages exist near trees and man-made structures during a lightning storm. Because trees and other man-made structures are usually not as well grounded as a tower, voltages encountered near trees and other structures are generally higher than near a

tower. These transient voltages disappear in a matter of microseconds. Under line fault conditions, a current flowing to ground through a tower will produce similar but lower voltage rises.

The voltages that a person in the vicinity of such an affected structure could be exposed to are commonly referred to as step and touch potentials. High voltage transmission lines are designed to reduce the possibility of flashover. Protective relaying is provided which will open circuit breakers and de-energize the line within 0.1 of a second.

3.3.5 Transformer Station Insulants

3.3.5.1 SF6 Switchgear

Ontario Hydro is completely satisfied that no risk is being imposed on its own employees or the public by the use of SF6 gas in Transformer Stations. The Institute of Environmental Studies of the University of Toronto has stated that the health hazard associated with the SF6 gas insulated stations would be negligible. This view is supported by the Ministries of Environment, Health and Labour.

Some of the outstanding properties of SF6 which make its use in power applications desirable are:

- arc-quenching ability
- thermal stability
- thermal conductivity.

In addition to these electrical and thermal properties, SF6 has many physical and chemical attributes which make it a suitable dielectric for the power industry.

Sulphur Hexafluoride is:

- chemically inert
- nontoxic
- nonflammable
- noncorrosive

A 100% concentration of SF6 gas would cause suffocation but that is true of any inert gas

including nitrogen which makes up 80% of the air we breathe.

Nitrogen, carbon dioxide and hydrogen are used in large quantities in many processes without undue risk to workers in the plant. The chance of anyone being exposed to a 100% concentration of SF₆ gas is almost nil. Any gas which escaped from the switchgear would gradually diffuse into the air and be dispersed by the building ventilation system. Any particular switchgear is divided into hundreds of compartments mainly to facilitate maintenance without replacement of more than the minimum amount of gas. Even the worst credible accident would not result in the simultaneous escape of the gas from more than a few of the compartments.

SF₆ gas when exposed to an electric arc can be decomposed. The decomposition products include the lower fluorides of sulphur.

The amount of SF₆ that would be decomposed in any one compartment of the SF₆ switchgear, if an arc should occur in that compartment, would depend on the arc current and the duration of the arc, i.e. the amount of energy released. Even in an extreme case, it would only be a small portion of the total volume of gas in the compartment. If the pressure relief diaphragm did not rupture, the contamination would be contained within the compartment but would not affect the future operation of the equipment. If the diaphragm did rupture, the decomposition products would, of course, be released. The volume would be extremely small, however, compared to the volume of the switchgear room and would not constitute any hazard to personnel. This minute amount of decomposed gas would eventually be exhausted into the atmosphere by the ventilation system. The concentration of these potentially obnoxious and/or toxic materials so vented would be a far less serious an environmental pollutant, than say the exhaust from cars passing on the street. Ontario Hydro is not aware of any arc on any of the 100 SF₆ switchgear stations in operation that has caused a rupture of an explosion vent diaphragm. In a telegram dated Feb. 9, 1976, one of the largest manufacturers states that in 300 circuit breaker years of equipment operation, there have been no arc failures of any kind on their equipment.

1 Within the circuit breakers units of the switchgear, a
2 controlled arc of very short time duration is formed
3 each time the breaker is opened when carrying current.
4 In fact, one of the principle advantages of the SF6
5 circuit breakers is the ability of SF6 to extinguish
6 this arc, and hence interrupt the current quickly. On
7 each such breaker opening, some very small amount of
8 gas decomposition will therefore occur. Enclosed in
9 each breaker compartment is a quantity of an activated
10 alumina-soda lime mixture which readily absorbs these
11 decomposition products to ensure repetitive breaker
12 operation. Tests carried out in France showed that
13 after over 500 separate breaker operations, at
14 currents covering the range one might expect in
15 service, that is, after a breaker lifetime of
16 operations, only 1/4 of 1% of the SF6 had been
17 decomposed and the ability of the activated alumina-
18 soda lime to absorb the decomposition by-products had
19 been less than half utilized, i.e. decompositon
20 products for another life of the breaker could be
21 absorbd with still some margin.

22 A French paper titled "Practical Consequences of
23 Research on the Decomposition by Arc of SF6" by Jean
24 AMALRIC et al published in REVUE GENERALE DE
25 L'ELECTRICITE, JUIN 1974, "Numero Special" gives further
26 data on the use of SF6 gas in power system switchgear.

27
28 Use of sulphur hexafluoride is not new to the
29 industrial environment. Besides being utilized in the
30 electirical apparatus, it can be introduced as a
31 blanket gas, similar to that of pure nitrogen, in the
32 manufacturing process of manganese to prevent
33 oxidation. There are at least two firms in Ontario
34 using this gas and workers are exposed daily without
35 any adverse symptions.
36

37 The toxic property of sulphur hexafluoride was first
38 investigated in 1950, and findings were reported in
39 the Archives of Industrial Hygiene and Occupational
40 Medicine (38). During the experiments, rats were
41 exposed to a concentration as high as 80% for 16 to 24
42 hours. No adverse health effects were observed.
43 These findings were confirmed by another indpendent
44 study in 1953. The Chemical Threshold Limit Value
45 Committee of the American Conference of Governmental
46 Industrial Hygienists, a body consisting of well-known
47 toxicologists, occupational physicians, engineers, and
48 chemists, concluded that this gas is physiologically
49
50

1 inert. Repeated exposures by humans at 1000 parts per
2 million (0.1%) or below for 8 hours a day would not
3 constitute a health hazard (39).
4

5 The data published by the Threshold Limit Value
6 Committee are based on the best current available
7 information from industrial experience, from
8 experimental human and animal studies, and when
9 possible from a combination of the three. These
10 values are determined with the objective of protection
11 against impairment of health, irritation, narcosis,
12 nuisance or other forms of stress, and these limits
13 are official documents applied throughout the United
14 States as well as in Canada, especially in Ontario.

15 Another experiment was carried out by the University
16 of Paris in 1967 where groups of rats inhaled 80%
17 decomposed gas and 20% oxygen for 1 to 2 hours. The
18 exposed animals presented no respiratory difficulties
19 or changes in behaviour; mortality remained zero.
20 Examination 24 hours later did not reveal any
21 pathological lesion of the lung tissues.
22

23 3.3.5.2 PCB Compounds 24

25 Some types of major equipment at stations use an
26 insulant of a synthetic non-flammable liquid of a non-
27 biodegradable, polychlorinated biphenol (PCB) compound
28 known commercially as askarel. Outdoor capacitor
29 banks and indoor transformers at stations are the main
30 examples. Its use in capacitor banks is because of
31 its highly desirable electrical characteristics which
32 are not presently attainable with alternative
33 insulants, while for indoor transformers it is because
34 of the fire resisting characteristic.
35

36 Special measures are taken to protect the environment
37 from this liquid. Provision is made to catch any
38 accidental leakage such as at new capacitor locations
39 by use of a sand trap with polyethylene liner.
40 Procedures have been implemented that require regular
41 inspections. The faulted equipment together with all
42 contaminated materials are sent to approved disposal
43 facilities in sealed metal containers.
44
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TYPICAL RADIO NOISE PROFILES
FOR 2,1-CCT 500kV LINES
TYPE Z11S TOWERS

CONDUCTOR SIZE = 4 x 0.95"
BUNDLE SPACING = 20" SQUARE
AVERAGE COND. HEIGHT = 57 FEET

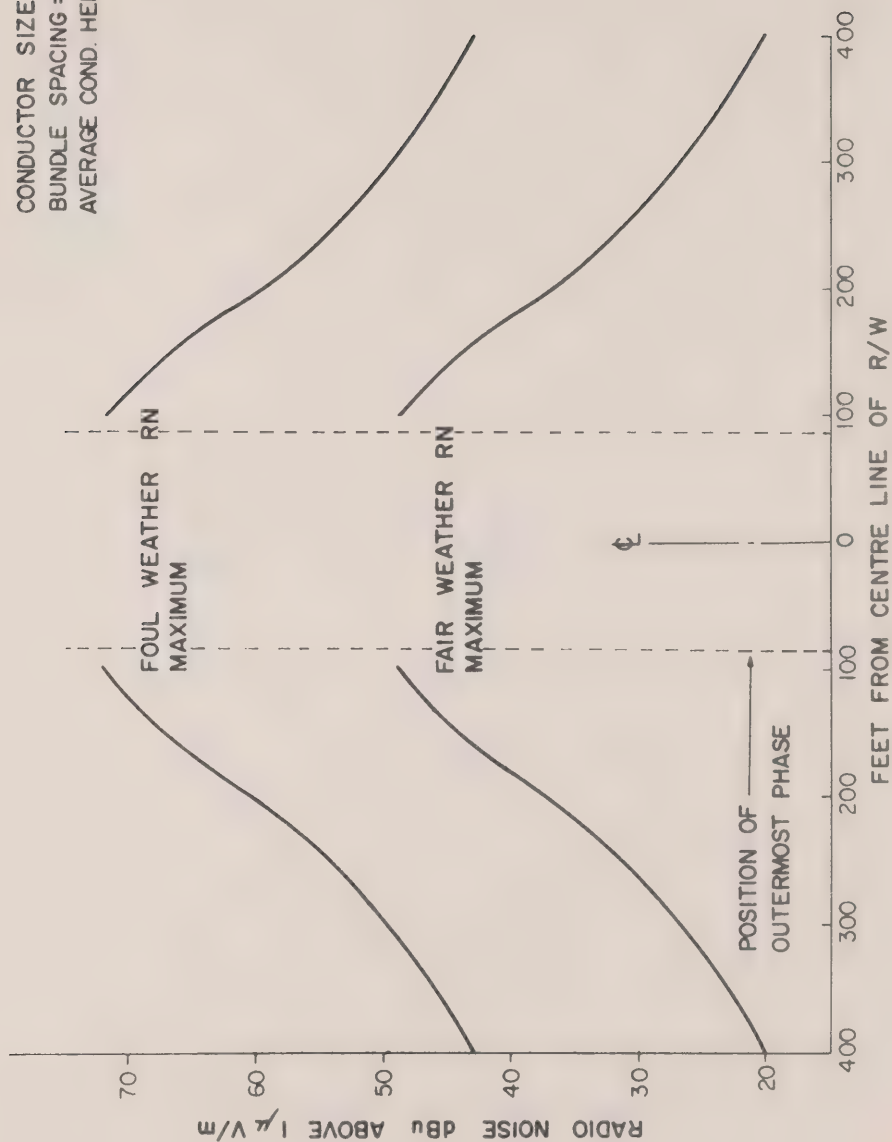


FIGURE 3.3.4-1

TYPICAL RADIO NOISE PROFILES
FOR 2-CCT 500kV LINES
TYPE V1 TOWERS

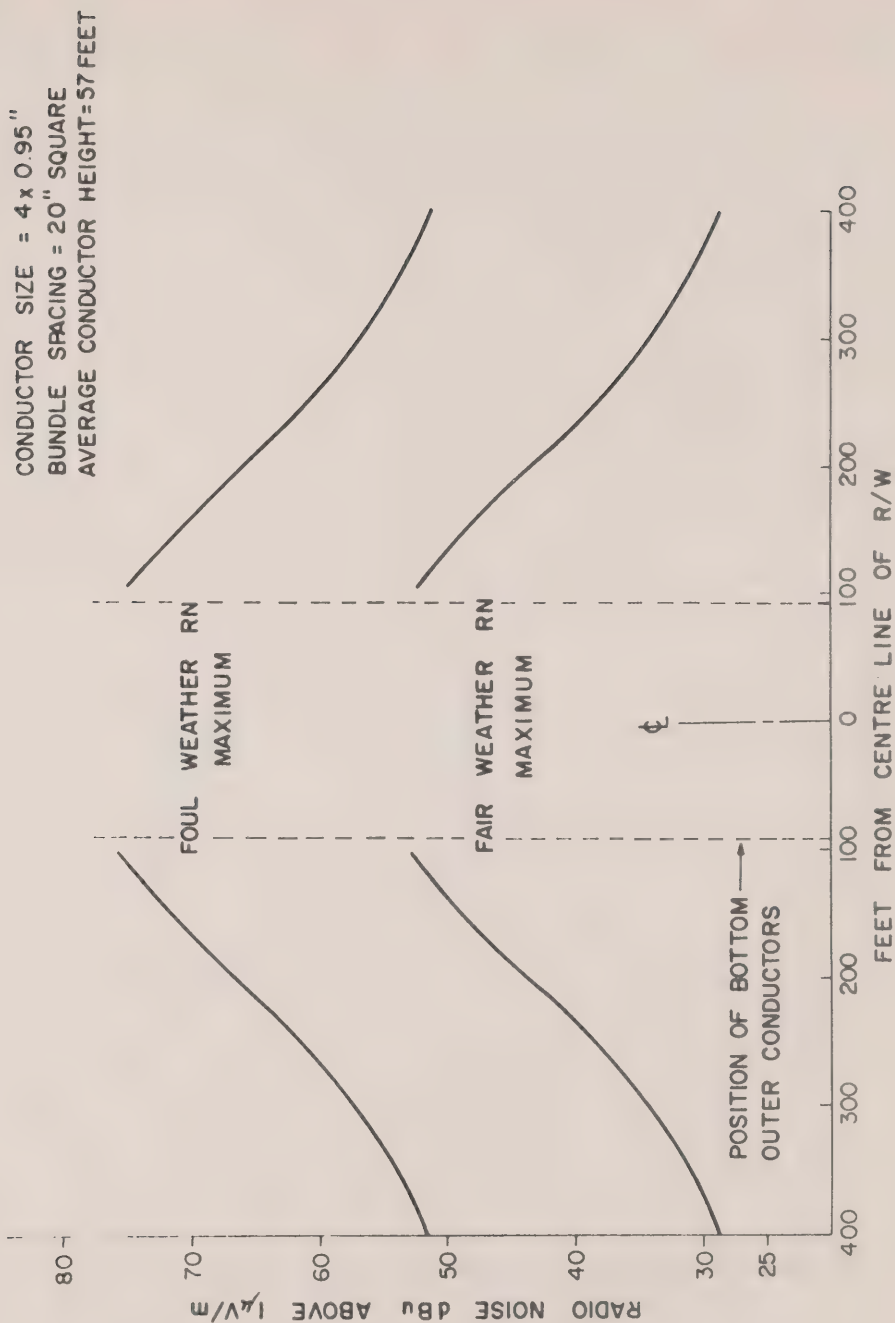


FIGURE 3.3.4 - 2

TYPICAL RADIO NOISE PROFILES
FOR 2, I-CCT 765 kV LINES
HYDRO QUEBEC RIGID TOWERS

CONDUCTOR SIZE = 4 x 1.4"
BUNDLE SPACING = 20" SQUARE
AVERAGE CONDUCTOR HEIGHT = 82 FEET

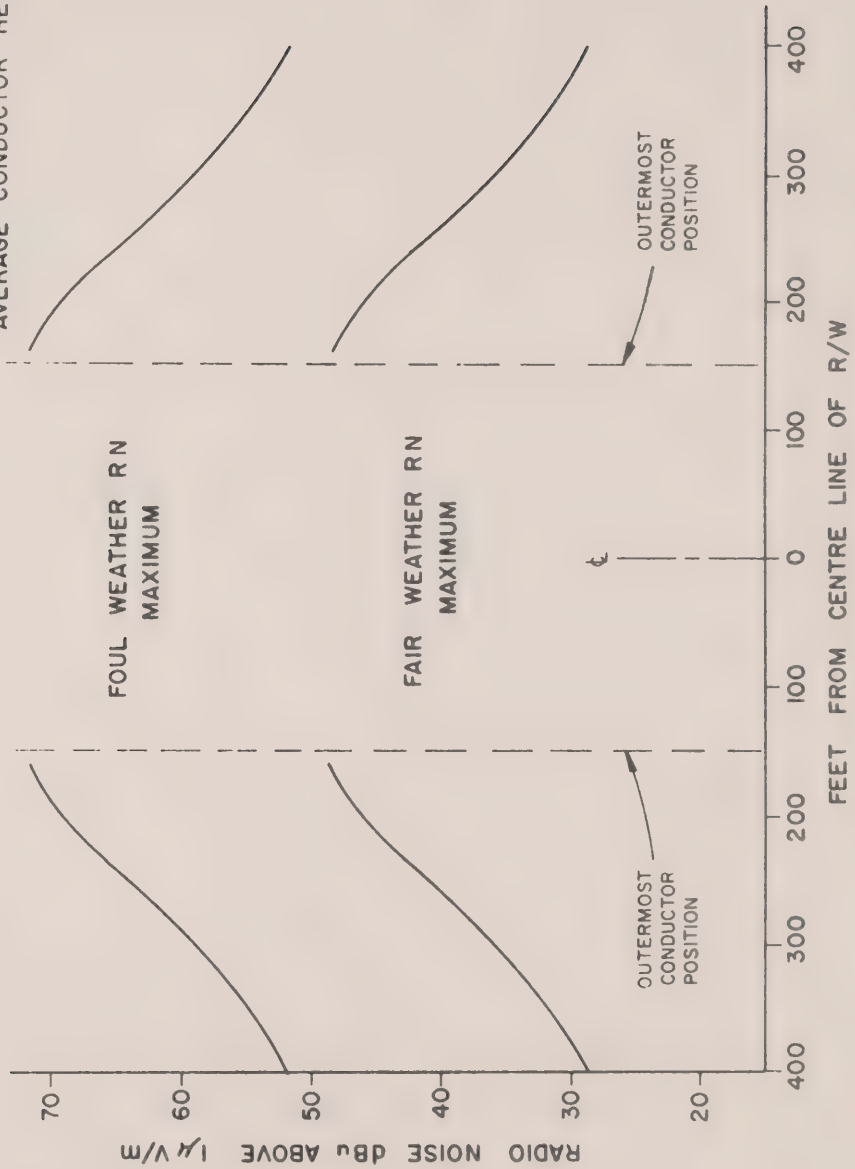


FIGURE 3.3.4-3

TYPICAL RADIO NOISE PROFILES
FOR 2, 2-CCT 230kV LINES
1948 TYPE TOWERS

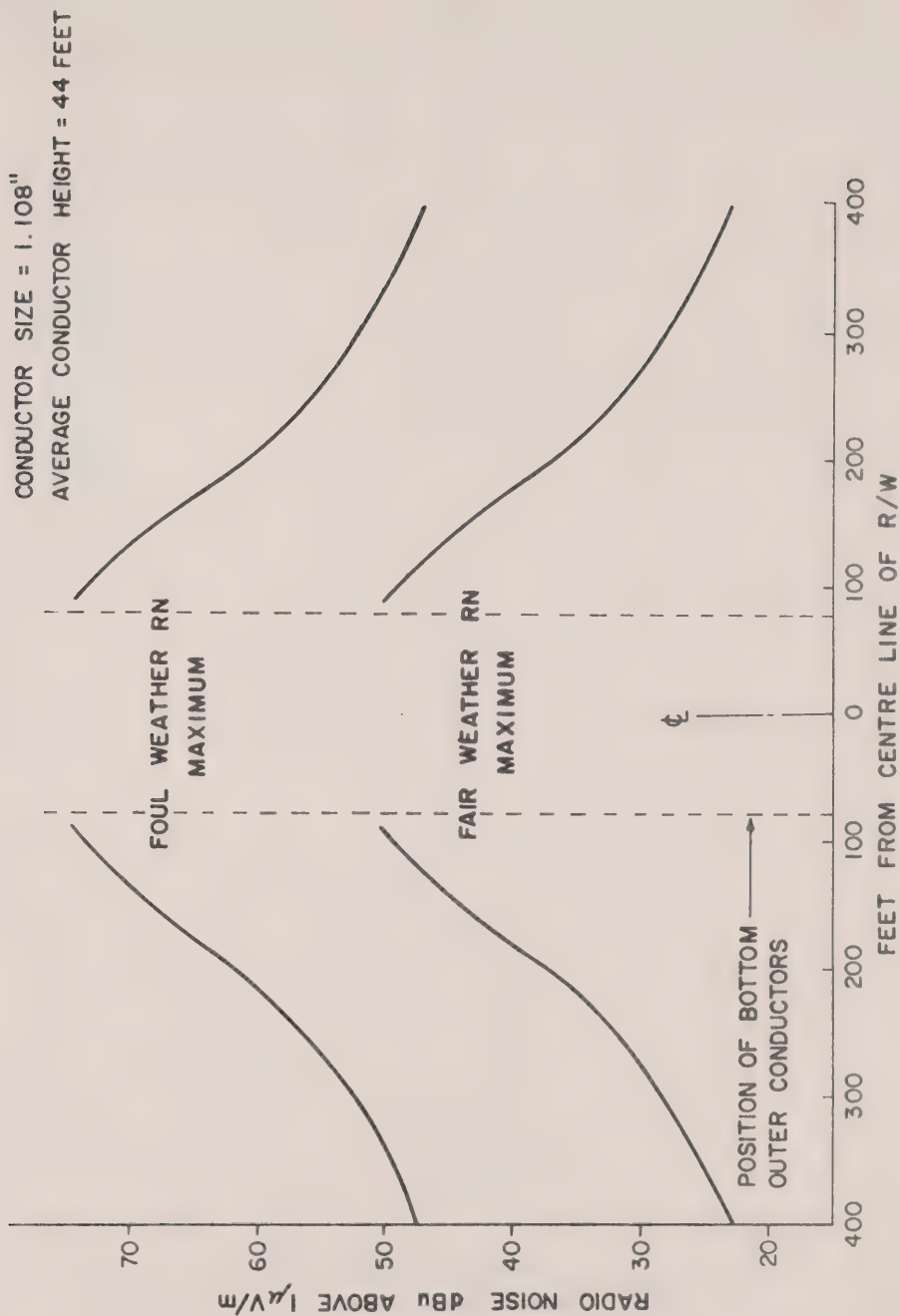


FIGURE 3.3.4 - 4

TYPICAL AUDIBLE NOISE PROFILES
FOR 2, 1-CCT 500KV LINES
TYPE Z11 TOWERS

CONDUCTOR SIZE = 4 x 0.95"
BUNDLE SPACING = 20" SQUARE
AVERAGE CONDUCTOR HEIGHT = 57 FEET

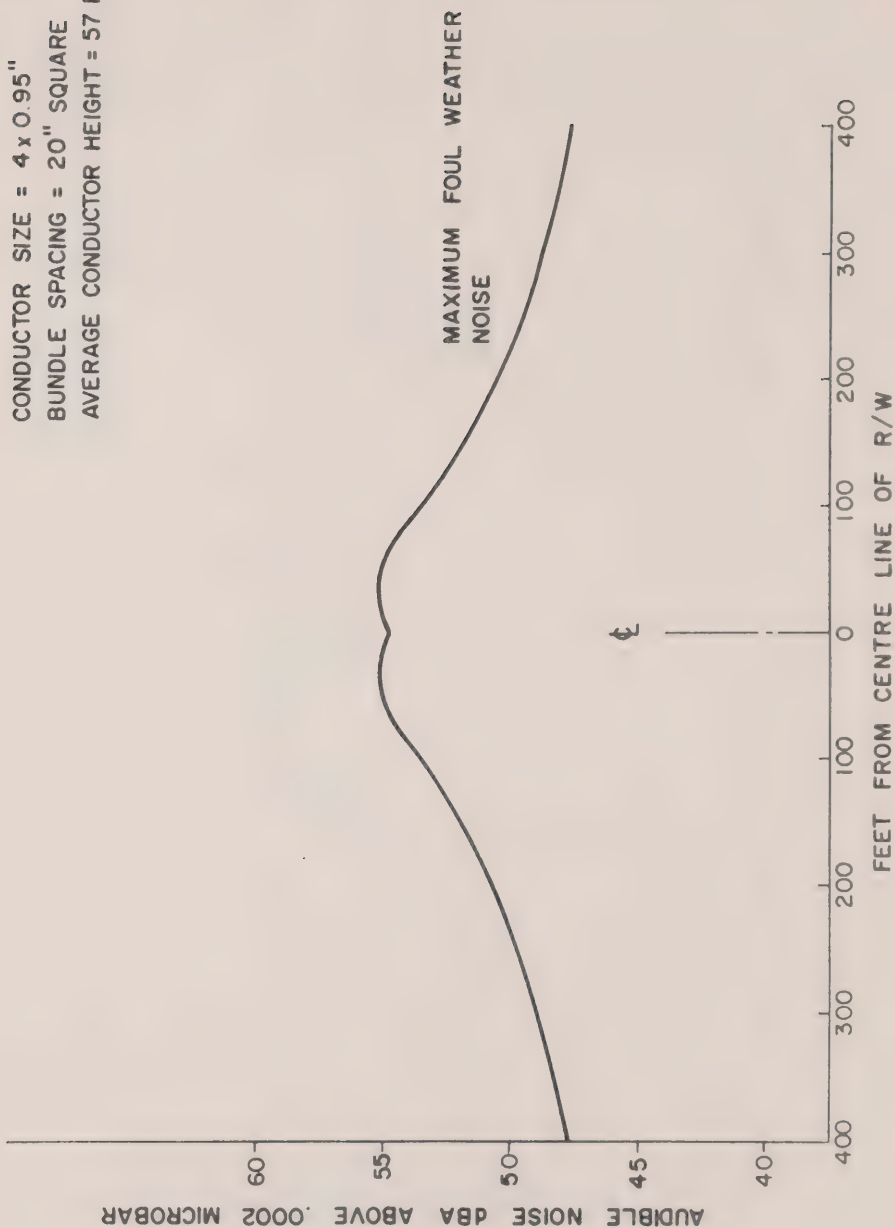


FIGURE 3.3.4-5

TYPICAL AUDIBLE NOISE PROFILES
FOR 2, 2-CCT 500kV LINES
TYPE V1 TOWERS

CONDUCTOR SIZE = 4 x 0.95"
BUNDLE SPACING = 20" SQUARE
AVERAGE CONDUCTOR HEIGHT = 57 FEET

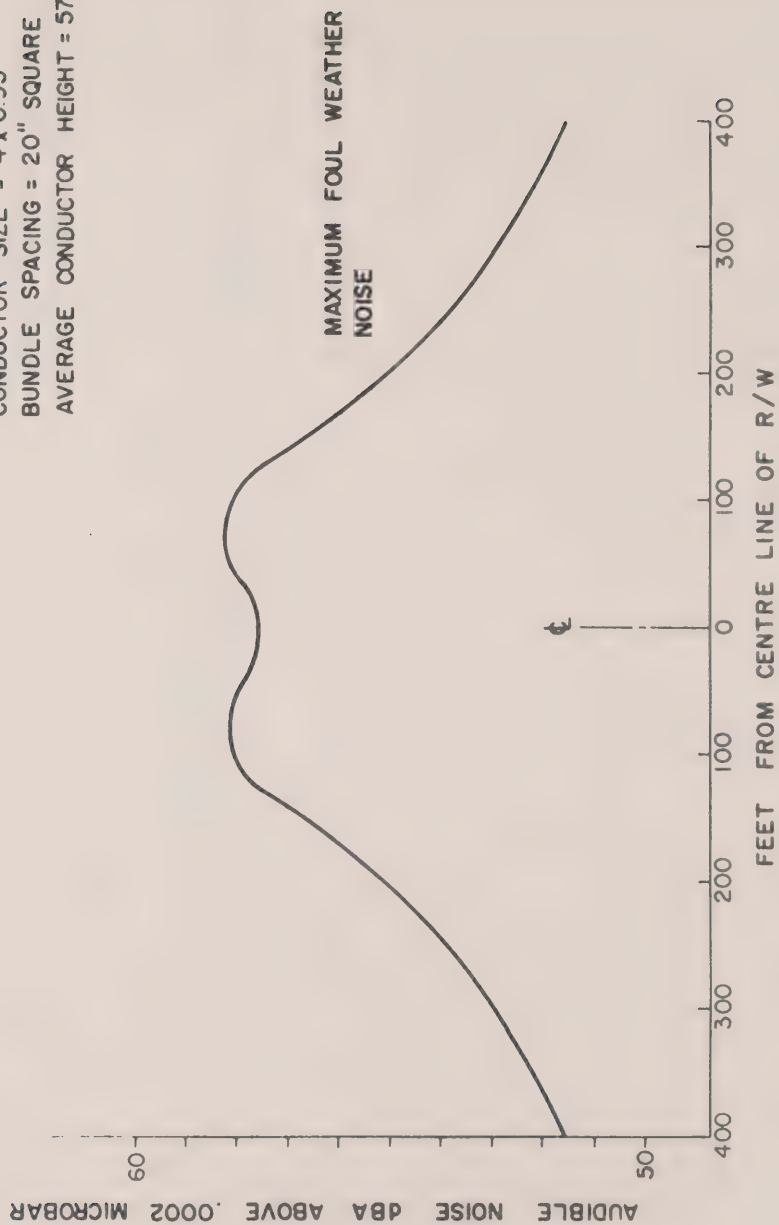


FIGURE 3.3.4-6

TYPICAL AUDIBLE NOISE PROFILES
FOR 2, 1-CCT 765kV LINES
HYDRO QUEBEC RIGID TOWERS

CONDUCTOR SIZE = 4 x 1.4"
BUNDLE SPACING = 20" SQUARE
AVERAGE CONDUCTOR HEIGHT = 82 FEET

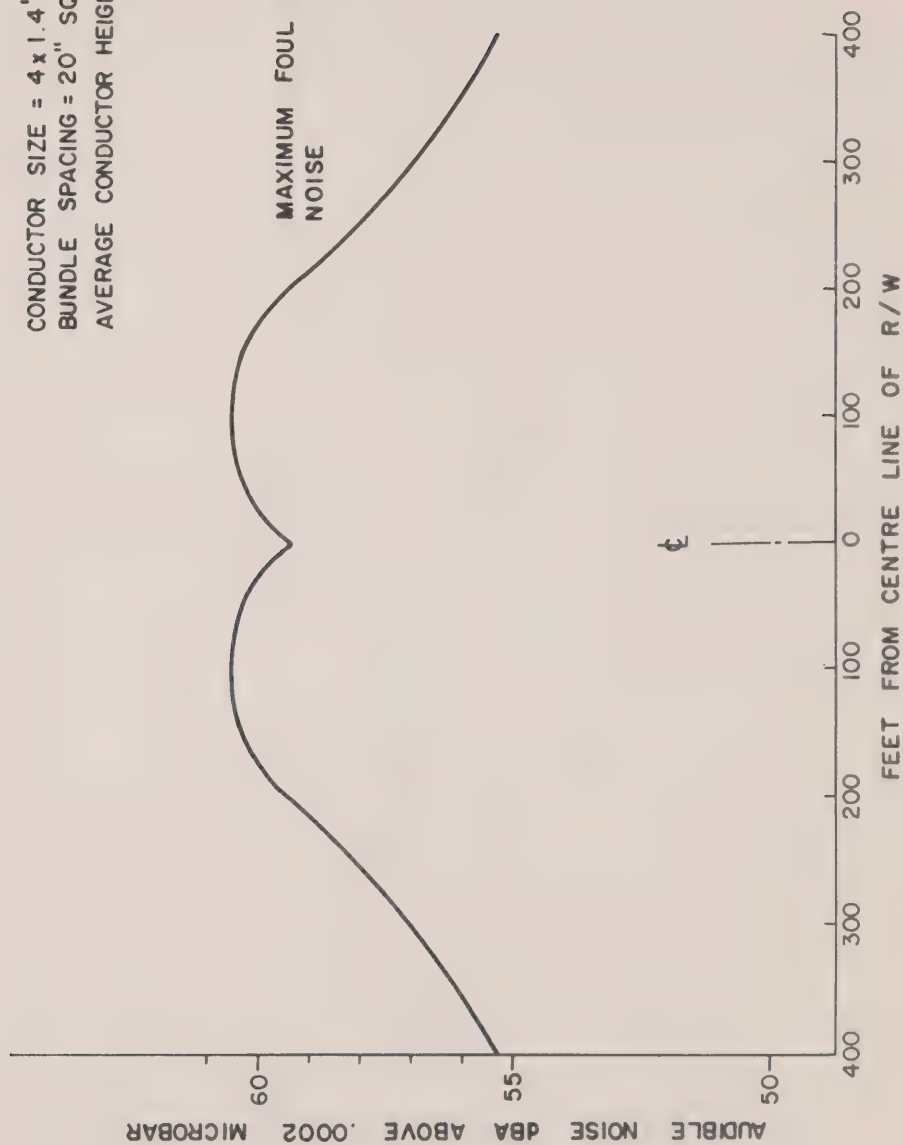


FIGURE 3.3.4-7

GROUND LEVEL VOLTAGE GRADIENT PROFILES
FOR 2, 1-CCT 500kV LINES
TYPE Z11 TOWERS

CONDUCTOR SIZE = 4 x 0.95"
BUNDLE SPACING = 20" SQUARE

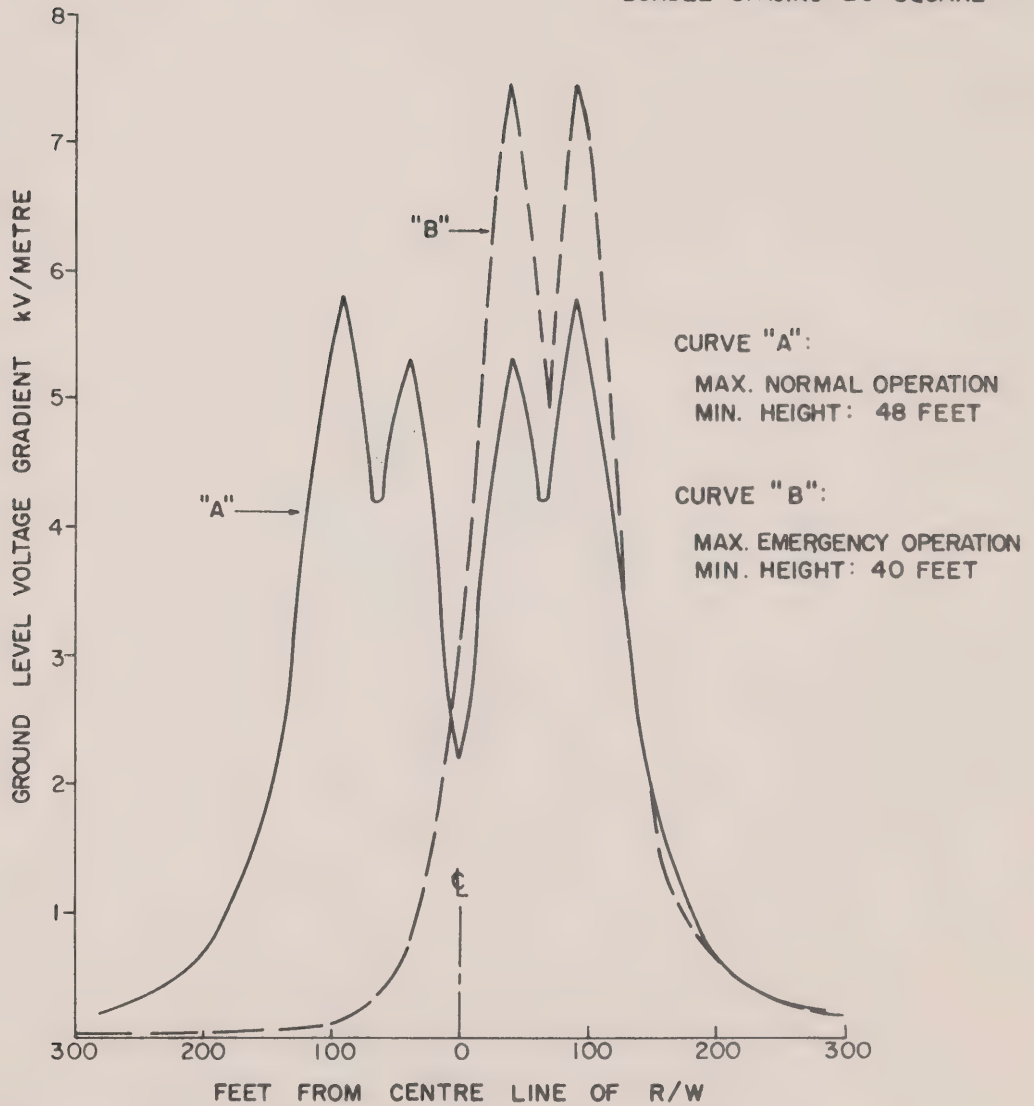


FIGURE 3.3.4-8

GROUND LEVEL VOLTAGE GRADIENT PROFILES
FOR 2, 2-CCT 500kV LINES
TYPE V1 TOWERS

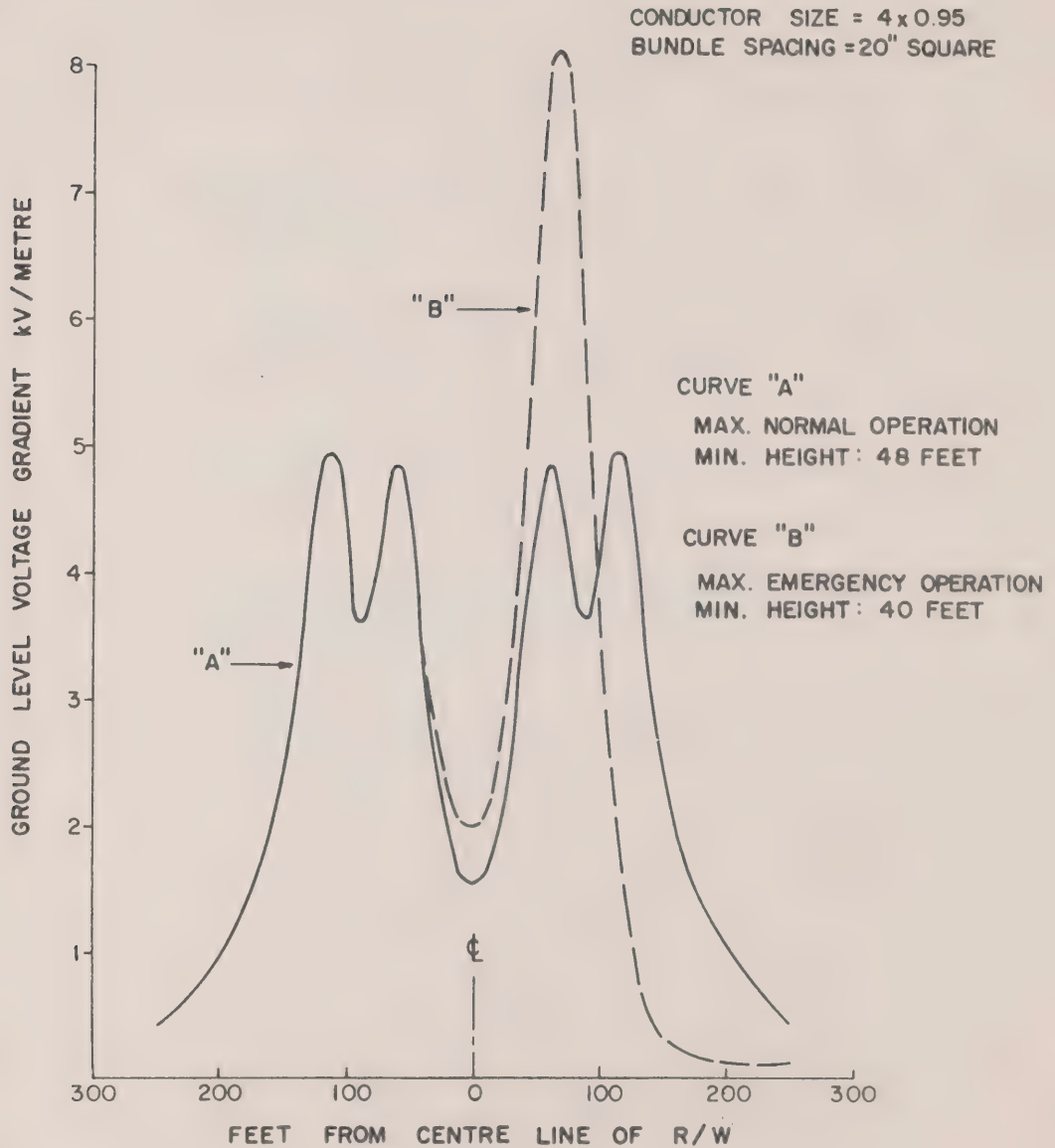


FIGURE 3.3.4-9

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